VOLUME XLVII NUMBER ONE

The NATIONAL GEOGRAPHIC MAGAZINE

JANUARY, 1925

CONTENTS

FOURTEEN ILLUSTRATIONS IN FULL COLOR

Seeing America from the "Shenandoah"
With 41 Illustrations — JUNIUS B. WOOD

The Palace of Versailles, Its Park and the Trianons
With 4 Illustrations — FRANKLIN L. FISHER

Versailles, the Magnificent
14 Autochromes Lumière — GERVAIS COURTELLEMONT

Chichen Itzá, an Ancient American Mecca
With 36 Illustrations — SYLVANUS GRISWOLD MORLEY

Interviewing the Stars
With 21 Illustrations — WILLIAM JOSEPH SHOWALTER

PUBLISHED BY THE
NATIONAL GEOGRAPHIC SOCIETY
HUBBARD MEMORIAL HALL
WASHINGTON, D.C.

$3.50 A YEAR 50¢ THE COPY

XUM

NATIONAL GEOGRAPHIC SOCIETY

GEOGRAPHIC ADMINISTRATION BUILDINGS

SIXTEENTH AND M STREETS NORTHWEST, WASHINGTON, D. C.

GILBERT GROSVENOR, President
JOHN OLIVER LA GORCE, Vice-President
JOHN JOY EDSON, Treasurer
BOYD TAYLOR, Assistant Treasurer
HENRY WHITE, Vice-President
O. P. AUSTIN, Secretary
GEO. W. HUTCHISON, Associate Secretary
EDWIN P. GROSVENOR, General Counsel
FREDERICK V. COVILLE, Chairman Committee on Research

EXECUTIVE STAFF OF THE NATIONAL GEOGRAPHIC MAGAZINE

GILBERT GROSVENOR, EDITOR

JOHN OLIVER LA GORCE, Associate Editor

WILLIAM J. SHOWALTER, Assistant Editor
RALPH A. GRAVES, Assistant Editor
FRANKLIN L. FISHER, Chief of Illustrations Division

J. R. HILDEBRAND, Chief of School Service

BOARD OF TRUSTEES

CHARLES J. BELL
President American Security and Trust Company

JOHN JOY EDSON
Chairman of the Board, Washington Loan & Trust Company

DAVID FAIRCHILD
In Charge of Agricultural Explorations, U. S. Department of Agriculture

C. HART MERRIAM
Member National Academy of Sciences

O. P. AUSTIN
Statistician

GEORGE R. PUTNAM
Commissioner U. S. Bureau of Lighthouses

GEORGE SHIRAS, 3D
Formerly Member U. S. Congress, Faunal Naturalist, and Wild-game Photographer

E. LESTER JONES
Director U. S. Coast and Geodetic Survey

WILLIAM HOWARD TAFT
Chief Justice of the United States

GRANT SQUIRES
Military Intelligence Division, General Staff, New York

C. M. CHESTER
Rear Admiral U. S. Navy, Formerly Supt. U. S. Naval Observatory

J. HOWARD GORE
Prof. Emeritus Mathematics, The George Washington University

FREDERICK V. COVILLE
Botanist, U. S. Department of Agriculture

RUDOLPH KAUFFMANN
Managing Editor The Evening Star

JOHN FOOTE, M. D.
Professor of Pediatrics, Georgetown University

JOHN OLIVER LA GORCE
Associate Editor National Geographic Magazine

CHARLES G. DAWES
Vice-President Elect of the United States

JOHN BARTON PAYNE
Chairman American Red Cross

A. W. GREELY
Arctic Explorer, Major General U. S. Army

GILBERT GROSVENOR
Editor of National Geographic Magazine

GEORGE OTIS SMITH
Director U. S. Geological Survey

O. H. TITTMANN
Formerly Superintendent U. S. Coast and Geodetic Survey

HENRY WHITE
Member American Peace Commission, Formerly U. S. Ambassador to France, Italy, etc.

STEPHEN T. MATHER
Director National Park Service

ORGANIZED FOR "THE INCREASE AND DIFFUSION OF GEOGRAPHIC KNOWLEDGE"

TO carry out the purposes for which it was founded thirty-seven years ago, the National Geographic Society publishes this Magazine. All receipts are invested in the Magazine itself or expended directly to promote geographic knowledge.

ARTICLES and photographs are desired. For material which the Magazine can use, generous remuneration is made. Contributions should be accompanied by an addressed return envelope and postage.

IMMEDIATELY after the terrific eruption of the world's largest crater, Mt. Katmai, in Alaska, a National Geographic Society expedition was sent to make observations of this remarkable phenomenon. Four expeditions have followed and the extraordinary scientific data resulting given to the world. In this vicinity an eighth wonder of the world was discovered and explored—"The Valley of Ten Thousand Smokes," a vast area of steaming, spouting fissures. As a result of The Society's discoveries this area has been created a National Monument by proclamation of the President of the United States.

AT an expense of over $50,000 The Society sent a notable series of expeditions into Peru to investigate the traces of the Inca race. Their discoveries form a large share of our knowledge of a civilization waning when Pizarro first set foot in Peru.

THE Society also had the honor of subscribing a substantial sum to the expedition of Admiral Peary, who discovered the North Pole.

NOT long ago The Society granted $25,000, and in addition $75,000 was given by individual members to the Government when the congressional appropriation for the purpose was insufficient, and the finest of the giant sequoia trees of California were thereby saved for the American people.

THE Society is conducting extensive explorations and excavations in northwestern New Mexico, which was one of the most densely populated areas in North America before Columbus came, a region where prehistoric peoples lived in vast communal dwellings and whose customs, ceremonies, and name have been engulfed in an oblivion.

THE Society also is maintaining expeditions in the unknown area adjacent to the San Juan River in southeastern Utah, and in Yunnan, Kweichow, and Kansu, China—all regions virgin to scientific study.

Copyright, 1924, by National Geographic Society, Washington, D. C., in the United States and Great Britain. All rights reserved. Entered at the Post Office at Washington, D. C., as Second-Class Mail Matter. Acceptance for mailing at special rate of postage provided for in Sec. 1103, Act of October 3, 1917, authorized July 1, 1918.

Governor Baxter of Maine

keeps to schedule with a Hamilton

PICTURED here is Governor Percival P. Baxter of Maine. With him is his dog "Garry." They are inseparable, as anyone around the State House can tell you.

But the governor has another constant companion. One who holds a high place in his affections. One whose faithfulness is also unswerving. This companion is his Hamilton Watch.

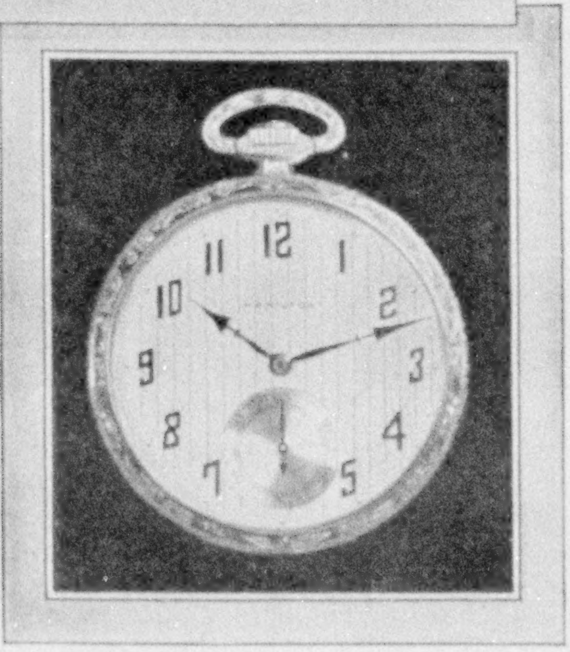
Governor Baxter is but one of thousands of men of large affairs who entrust their daily schedules to the railroad accuracy of the Hamilton. Wherever men set store by unfailing punctuality you will find a large proportion of Hamiltons.

The next time you pass your jeweler's, stop in and have him show you the various Hamilton Watches, both pocket and strap models. As you look at their artistic beauty, remember that these are watches built for the stern purpose of measuring time accurately. The outward beauty is but a promise of inward worth.

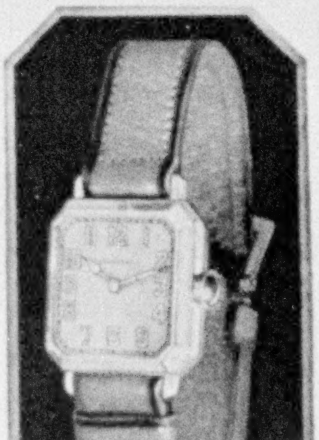
HAMILTON WATCH COMPANY

On the Lincoln Highway, Lancaster, Pa., U. S. A.

Send for a copy of our new illustrated booklet, "The Timekeeper"



Hamilton Watches may be had in 14K green, yellow, or white gold; also in gold filled, green, white or yellow—plain or engraved. Prices, $46 to $250. You can choose from a wide variety of cases and dials.

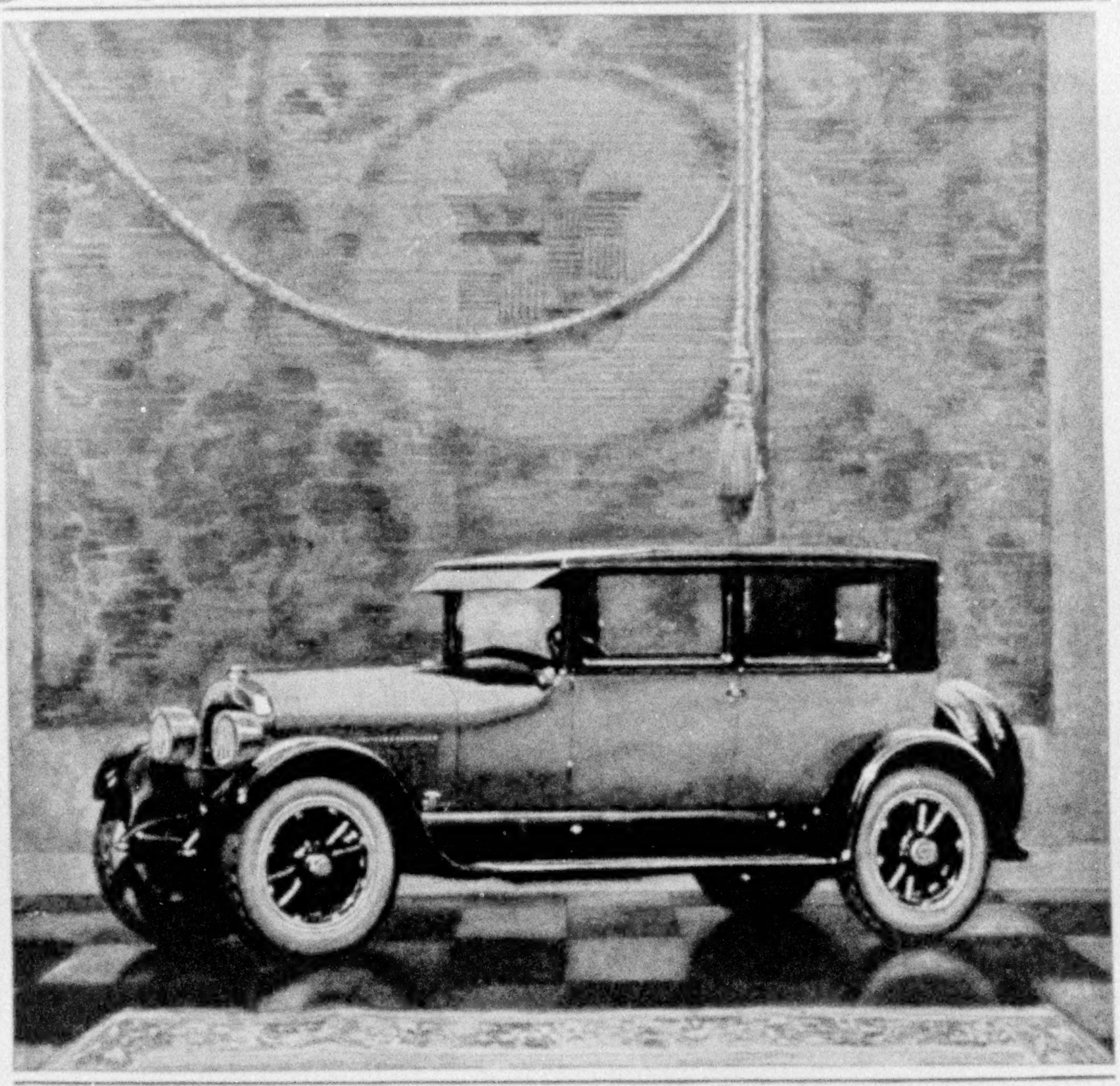


Men's strap watches with Hamilton accuracy at $50 to $85.

Women's wrist watches, $46 to $65.

Hamilton Watch

The Watch of Railroad Accuracy



CADILLAC · COACH

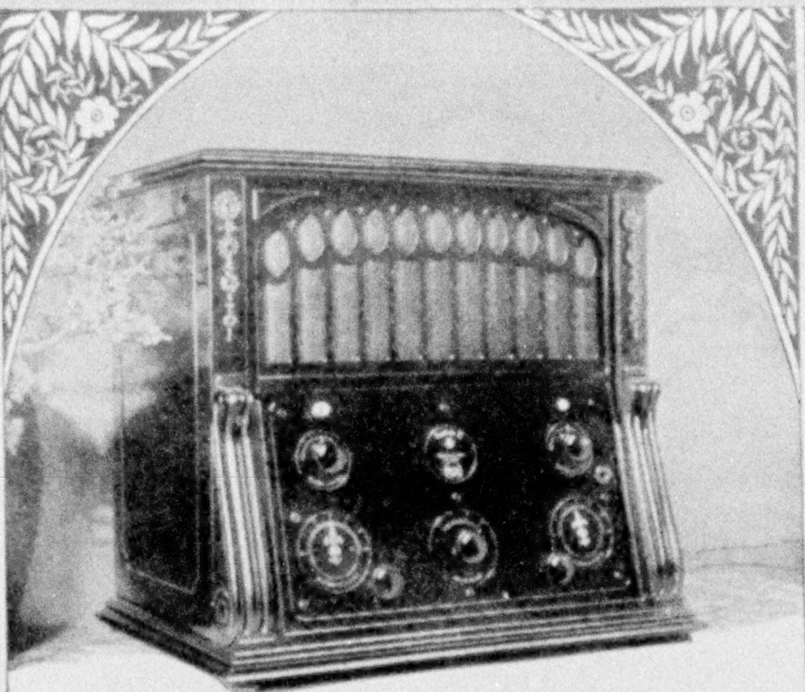
THE Cadillac Motor Car Company presents an entirely new and beautiful coach with body by Fisher, on the standard V-63 chassis. The dependability and comfort which have created world-wide desire for Cadillac ownership are here combined with a new type, large five-passenger enclosed body of utmost utility—and at a price most attractively low. This car is further proof of Cadillac's foremost position in fine car manufacture. Now on display by Cadillac dealers, also at the National Motor Shows.

CADILLAC MOTOR CAR COMPANY
DETROIT, MICHIGAN
Division of General Motors Corporation

S T A N D A R D   O F   T H E   W O R L D

V-63

RADIOLA X



THE "distance fan" is now a *listener!* The thrill of radio is no longer in getting fifty stations in a night, for radio has conquered distance, and turns now to music.

Music from far stations—music from near stations—*clear* and *true!* No longer will horn sounds, noises, thinned and flattened tones pass for music because they come from far away. In the Radiola X, each thread of sound reaches your room as it was played or sung. Speech is clear, voices are *real.*

The engineers have kept pace with the broadcasters—have improved reception to meet an ever-widening world of fun. With the simplicity, the beauty, and the *tone quality* of Radiola X, the home becomes a fascinating corner in a world of new interests and new pleasures.

"*There's a* Radiola *for every purse*"

Radio Corporation of America

Sales Offices: Suite No. 351

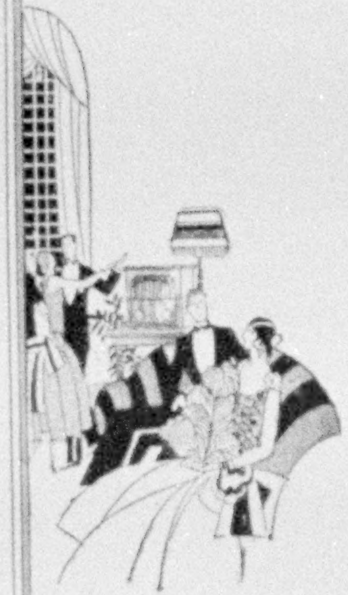
233 Broadway, New York 10 So. La Salle St., Chicago, Ill. 28 Geary St., San Francisco, Cal.

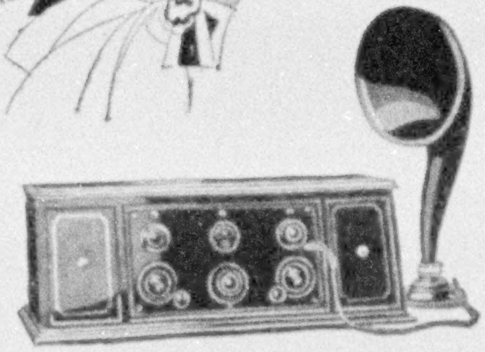
Radiola

REG. U. S. PAT. OFF.

RADIOLA X

—the famous Regenoflex circuit, in a rich mahogany cabinet, with a built-in loudspeaker, and space for the batteries. With four Radiotrons WD-11. Complete except batteries and antenna $245





RADIOLA REGENOFLEX

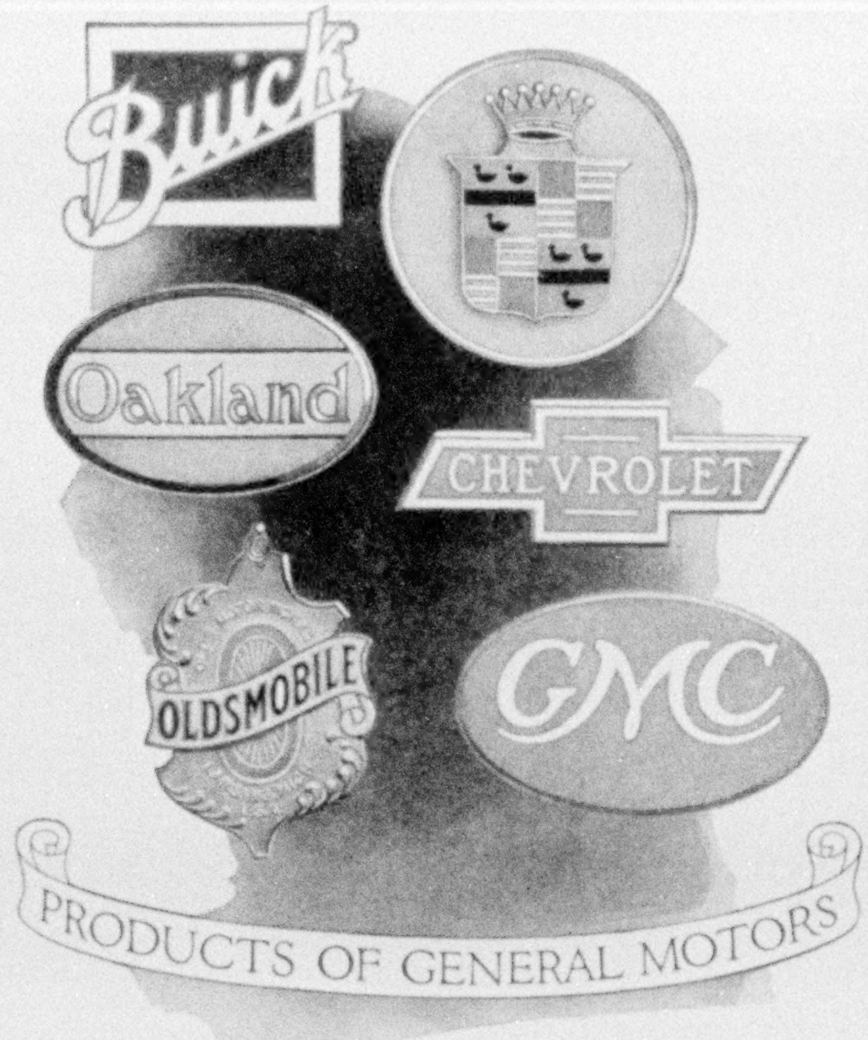
—sensitive, clear-toned, non-radiating. With four Radiotrons WD-11 and Radiola Loudspeaker. Space inside for the batteries. Entirely complete except batteries and antenna $191

Uses only dry batteries.

RCA

This symbol of quality is your protection

FACTS ABOUT A FAMOUS FAMILY



A car for every purse and purpose

IN THE automobile industry several distinct price classes have developed.

General Motors, a family of car and truck builders, offers a choice of models in each class. In Buick, Cadillac, Chevrolet, Oakland, Oldsmobile and GMC Trucks, there is a car for every purse and purpose.

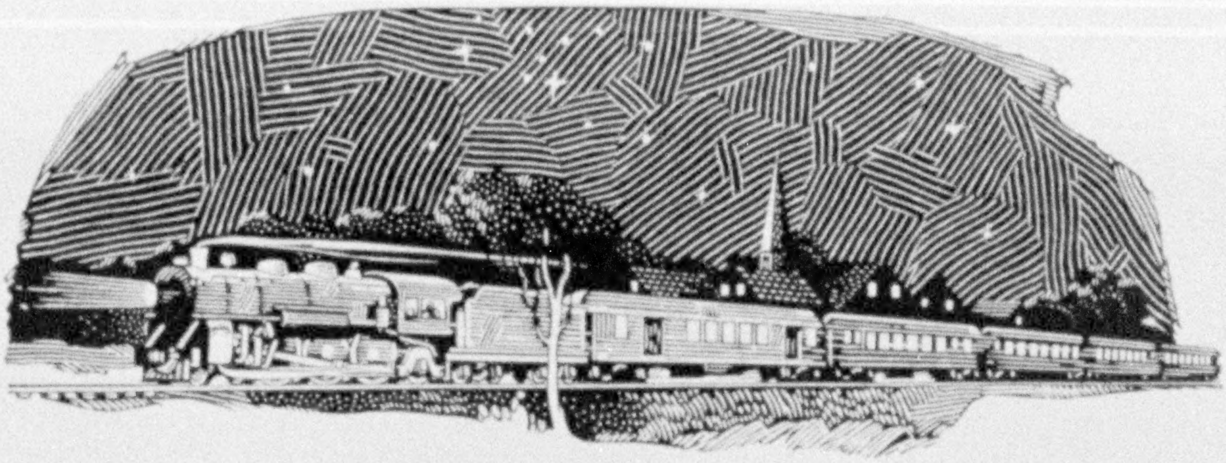
Back of each car are all the resources of General Motors—an assurance of scientific excellence, continuing service, satisfactory value, and a sound and fair plan for purchase out of income.

GENERAL MOTORS

BUICK · CADILLAC · CHEVROLET · OAKLAND
OLDSMOBILE · GMC TRUCKS

General Motors, trucks and Delco-Light products may be purchased on the *GMAC* Payment Plan. Insurance service furnished by General Exchange Corporation.

ELGIN TAKES THE TIME FROM THE STARS



Look up to the Stars
if you would see the source of Elgin time

THE Italian Galileo produced the first high power astronomical telescope 325 years ago—and the study of the stars entered its modern scientific phase.

Today, as you look at your Elgin watch, you receive the practical benefit of Galileo's genius—and of the patient work of the astronomers who came after him and contributed to man's knowledge of the stars.

For Elgin calls upon astronomy for the precise time-standards which govern the making of the *professional* time-keeper. *Elgin takes the time from the stars*—which astronomy has shown to be the final and absolute measure of time.

The Elgin Time Observatory was established for the whole purpose of making star observations and recording *exact* time. It was put in charge of astronomers of national prominence.

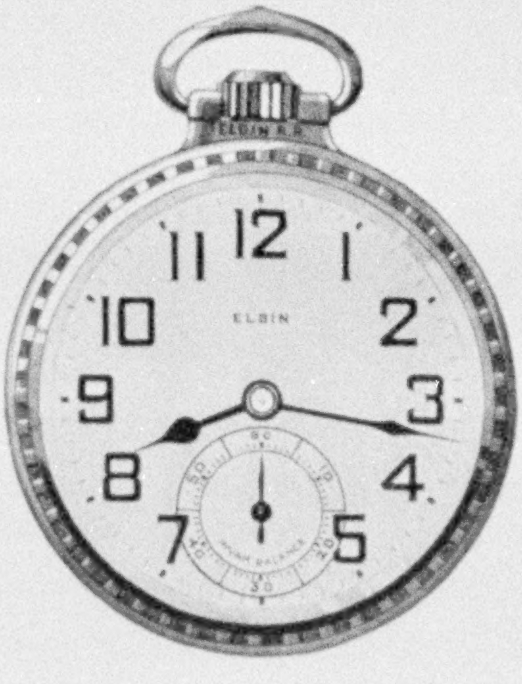
And every step in making and timing an Elgin watch is governed by the standards of time—*and the ideals of accuracy*—which they bring down from the stars.

* * *

The Elgin viewpoint is the *professional* viewpoint.

Year by year, its influence is reaching out—and year by year, men and women are buying *better and better* watches.

Your jeweler will show you Elgin Watches in a wide variety and his advice as to the selection of your Elgin will be valuable.

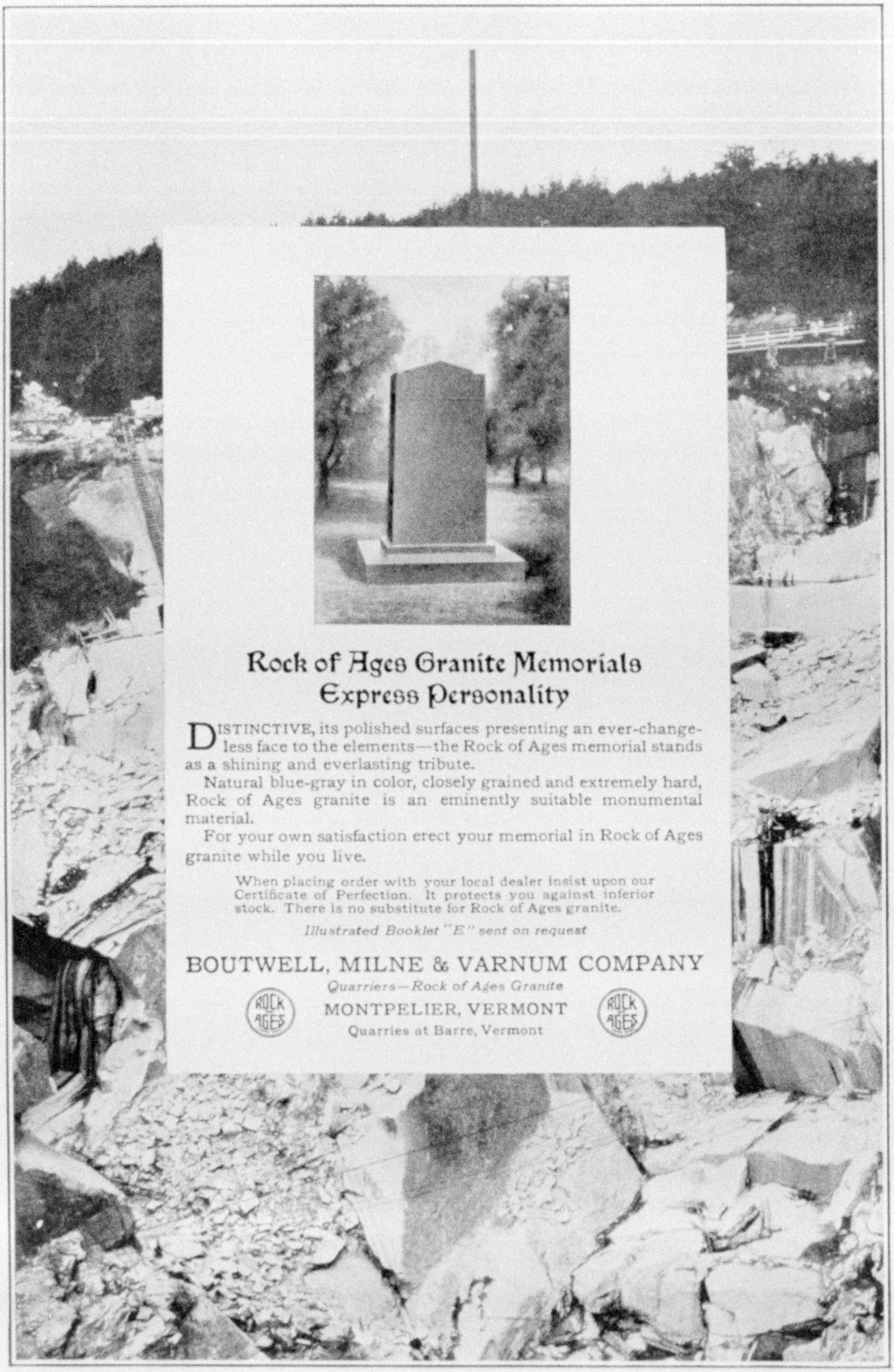


The new Elgin "B. W. Raymond" Railroad Watch is supplied with two types of balance wheel—the Elgin regular steel balance and the Elgin special Invar balance

ELGIN
The Professional Timekeeper

ELGIN NATIONAL WATCH COMPANY, ELGIN, U.S.A.

XUM


Rock of Ages Granite Memorials
Express Personality
DISTINCTIVE, its polished surfaces presenting an ever-changeless face to the elements—the Rock of Ages memorial stands as a shining and everlasting tribute.
Natural blue-gray in color, closely grained and extremely hard, Rock of Ages granite is an eminently suitable monumental material.
For your own satisfaction erect your memorial in Rock of Ages granite while you live.
When placing order with your local dealer insist upon our Certificate of Perfection. It protects you against inferior stock. There is no substitute for Rock of Ages granite.
Illustrated Booklet "E" sent on request
BOUTWELL, MILNE & VARNUM COMPANY
Quarriers—Rock of Ages Granite
MONTPELIER, VERMONT
Quarries at Barre, Vermont

Will you accept this book FREE

"Just what I have always wanted!"

MILLIONS upon millions of books fill the shelves of our libraries. Within their covers are treasures richer than Ali Baba's cave ever held. Here is knowledge, education, culture, entertainment. The jewels of civilization are within these books. What priceless benefits we could obtain from them —*if only we had time to read them!*

How can we hope to read even a small fraction of all the good books in the world? Which are the ones we should read, and where shall we begin?

The answer to a vital need

The book you see pictured above is a solution to the reading problem of the busy man or woman. Here at last is the key to the literature of the world. For this book contains the famous new reading plan created by nine eminent men of letters—Dr. Lyman Abbott, John Macy, Richard Le Gallienne, Asa Don Dickinson, Dr. Bliss Perry, Thomas L. Masson, Dr. Henry van Dyke, George Iles, and Dr. Hamilton Wright Mabie.

A unique new plan

From the immortal literature of the world these men have selected just the elements essential to a cultured person's reading. These selections they have arranged in a day-by-day program covering a full year. And the selections are so arranged as to be of timely interest.

For example, on July 14th, the anniversary of the fall of the Bastille, our reading takes us into the stirring days of the French Revolution.

In this way your reading is filled with fascinating variety; it takes you among the masterpieces of fiction, historical description, poetry, drama, essays, biography. *Only twenty minutes a day are required.*

Already this fascinating new plan of reading has been hailed with delight by thousands. "This is just what I have always wanted!" people say when they see this book—the only book of its kind in the world.

A remarkable offer

It would be difficult to set a price upon The Daily Reading Guide. Its value to intelligent men and women is almost inestimable. But you are not asked to purchase The Daily Reading Guide. A remarkable offer brings it to you FREE. A limited number of copies are to be distributed without cost in the encouragement of good reading.

Simply mail the coupon, enclosing only 25 cents to help cover the costs of handling and postage, and The Daily Reading Guide will come to you at once. It is important to send at once.

Nelson Doubleday, Inc.
Dept. Y-621
Garden City,
New York

Nelson Doubleday, Inc.
Dept. Y-621
Garden City, N. Y.

Gentlemen: Please send me, without obligation, a copy of The Daily Reading Guide, containing nearly 200 pages, bound in rich blue cloth, which contains the complete new plan for reading the essential literature of the world in only 20 minutes a day. I enclose 25 cents (in currency or stamps) to pay handling and shipping charges. There is to be no further cost.

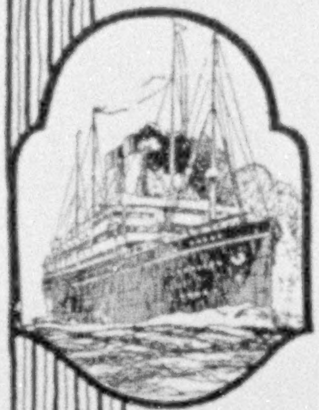
Name ....

Address ....

City .... State ....

Winter Cruises

EGYPT and the MEDITERRANEAN
46 Days



Red Star Liner **Lapland**
From New York Jan. 17.

White Star Liner **Adriatic**
From New York Feb. 26.

Also **Lapland,** March 8
Back in New York 46 days later.

Madeira, Gibraltar, (Algeciras), Algiers, Monaco, Naples, Athens, Constantinople, Haifa (for Holy Land), Alexandria (for Cairo and the Nile country). Naples and Monaco on return voyage. Optional stopovers in Palestine and Egypt.

WEST INDIES
30-31 Days

More than 25 years specialized experience in West Indies cruises.

White Star Liner **Megantic** (specially constructed for cruises in the tropics).

From New York Jan. 22 and Feb. 25, returning 30-31 days later.

Havana, Santiago, Haiti, Kingston, Panama Canal, Cartagena, Curaçao, LaGuaira, Port of Spain, Barbados, Fort de France, St. Thomas, San Juan, Nassau. *Cruise may be joined from Florida at Havana and left at Nassau for a longer vacation.*

For complete information and descriptive booklets apply Cruise Department, No. 1 Broadway, New York,

WHITE STAR LINE
RED STAR LINE

our offices elsewhere, or any authorized steamship agent.

Announcing the MAGNIFICENT, NEW

Book-Cadillac
in DETROIT

Opening the week of December 1, 1924, the new Book-Cadillac Hotel, Detroit, immediately takes rank with the finest hostelries of Europe and America.

The Book-Cadillac rises on the site of the former Hotel Cadillac at the intersection of Washington Boulevard and Michigan Avenue. Towering twenty-nine stories above the street, with twelve hundred rooms and bath, it is the tallest hotel structure in the world.

Under the personal direction of Mr. Roy Carruthers, nationally recognized authority in hotel management, every facility is provided for extending maximum courtesy and comfort to guests.

BOOK-CADILLAC HOTEL COMPANY, DETROIT
ROY CARRUTHERS, *President*
R. J. TOMPKINS, *Resident Manager*

MISCHA LEVITZKI AT HIS STEINWAY

STEINWAY

THE INSTRUMENT OF THE IMMORTALS

In that dramatic moment of quiet before the first note is struck, the concert pianist marshals swiftly all his genius, his spirit, his skill. And there is scarcely a great pianist since Liszt who has not drawn, in that moment, new courage from his utter confidence in his chosen instrument—the Steinway. Paderewski, Hofmann, Levitzki—these and others of the great pianists know how perfectly the Steinway translates the mellow, golden harmonies of Schumann or the sharply etched roulades of a Bach fugue. They know how the Steinway at a touch becomes a singing animate voice, instantly responsive to the most extraordinary demands.

This knowledge of the superiority of the Steinway is shared by the public at large. For the great majority of Steinway pianos are purchased on limited incomes and for unassuming homes. As a matter of principle, it has been kept within the reach of every true lover of music—sold at the lowest possible price and upon the most convenient terms. Each of the various models is a true Steinway. And each will return, decade after decade, full measures of pleasure and delight. You need never buy another piano.

There is a Steinway dealer in your community or near you through whom you may purchase a new Steinway piano with a small cash deposit, and the balance will be extended over a period of two years. *Used pianos accepted in partial exchange

Prices: $875 and up

Plus transportation

Steinway & Sons, Steinway Hall
109 East Fourteenth Street, New York

This tree is one of a dozen fine oaks on the estate of James Bliss Coombs, Sound Beach, Conn.

25 years ago
this would have been a miracle

In 1920 this tree was badly decayed and in serious danger. Davey Tree Surgeons treated it skilfully and filled the cavity with cement by the Davey sectional method. Today the tree is almost healed over by new bark and the tree is in perfect condition. Every tree treated on the Coombs place is equally perfect.

Twenty-five years ago it would have been a miracle to achieve such results even in one case. Today Davey Tree Surgeons do it regularly with tens of thousands of trees every year.

Davey Tree Surgeons are local to you—anywhere between Boston and Kansas City, between Canada and the Gulf. Write or wire Kent, Ohio.

THE DAVEY TREE EXPERT CO., INC.
2 City Bank Building, Kent, Ohio

Attach this coupon to your letterhead and mail today

Reg. U. S. Pat. Off.

THE DAVEY TREE EXPERT CO., Inc.,
2 City Bank Bldg.,
Kent, Ohio

Gentlemen: Without cost or obligation on my part, please have your local representative examine my trees and advise me as to their condition and needs.

FLOWERS—to your Friends on outgoing steamers, to last all the way across. · · For business openings, birthdays, receptions, to last a week. Flowers for every other occasion. · ·

Write for current price list.—
Send 25c. for Gift Catalog, in natural colors, money will be credited to first order

We deliver flowers in New York within 2 hours. In every other city in the world, able representatives to whom we transfer your order by wire or cable, fill it with scrupulous care in a few hours.

MAX SCHLING ·INC·
THE Telegraph Florist of New York.
785 FIFTH AVE. at 60th St.
Telephone Regent 8060 ·

Mediterranean

PALESTINE—EGYPT
The Luxury Cruise, leaving
New York, Feb. 4, 1925
by the famous "ROTTERDAM" (Fourth Cruise) Under the HOLLAND-AMERICA LINE'S own management

The "ROTTERDAM"
24,170 tons register, 37,190 tons displacement

Has a world-wide reputation for the magnificence and comfort of her appointments, the surpassing excellence of her cuisine and the high standards of service and management on board.

66 days of Delightful Diversion

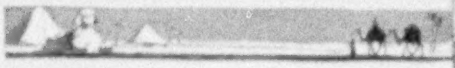
ITINERARY includes Madeira, Lisbon, Cadiz, Seville, Gibraltar, Algiers, Tunis, Athens, Constantinople, the Holy Land and Egypt, Italy, and the Riviera. Carefully planned Shore Excursions. Stop-over in Europe. Cruise limited to 550 guests.

American Express Company agents in charge of shore Excursions

Illustrated Folder "N" on request

For choice selection of accommodations make reservations NOW

HOLLAND-AMERICA LINE
21-24 State St., New York
Boston Philadelphia Pittsburgh Chicago Minneapolis St. Louis Detroit Atlanta, Ga. Seattle New Orleans San Francisco Montreal Toronto Mexico City
Or any authorized Steamship Agent



—CRUISES—

WEST INDIES

If you plan a brief winter holiday, no field will prove so picturesque as the West Indies, no journey so diverting as a cruise, no West Indies cruises so generally complete as ours. Two points we should like to emphasize—our ship, the 20,000-ton "Reliance", is the finest ship ever to cruise the Caribbean, and ours are the only cruises circling the West Indies to include all shore excursions in the cruise-price. The routes include Havana, Jamaica, the Panama Canal, Colombia, Venezuela, Trinidad, Barbados, Martinique, St. Thomas, Bermuda, etc. A fortnight's cruise, to Bermuda, Porto Rico, Jamaica and Havana, sails January 13 (*$175 & up*). Two longer cruises visiting a dozen or so ports, sail January 31 & February 28. (*$350 & up*).

A Delightfully Novel Spring Cruise

To the Mediterranean

Sailing March 28 on the "Reliance" for five weeks in Madeira, Spain, Algiers, the Balearic Islands, Tunis, Sicily, Naples, Monte Carlo, Nice and Cherbourg. An ideal spring voyage, perfect as a prelude to a summer Abroad. $525 & up.

Other Notable Raymond-Whitcomb Cruises

Round South America Cruise—S.S. "Resolute", January 24. $925 & up.
Winter Mediterranean Cruise—S.S. "Samaria", February 5. $875 & up.
Summer Mediterranean Cruise—S.S. "Oronsay", June 27. $675 & up.
Midnight Sun Cruise (Norway)—S.S. "Franconia", June 30. $725 & up.
Round the World Cruise (including Australia, New Zealand, Tasmania)—S.S. "Carinthia", October 10. $2000 & up.

Send for Booklets, Ship-plans, Travel Guides, etc.

NEW YORK
PHILADELPHIA
CHICAGO

Raymond & Whitcomb Company

SAN FRANCISCO
LOS ANGELES

Executive Offices: 22 Beacon Street, Boston

Why Not a Trip to France

instead of a summer cottage?

Aren't you a bit tired of your cottage at the beach—the chatter from the same old crowd? Your camp in the mountains?

Why not rent both places and go to France this summer? Spend a week or so in Paris, international capital of all gayety. Shop in the Rue de la Paix. Dine outdoors at the chic restaurants in the Bois. Enjoy the plays, the races, the opera.

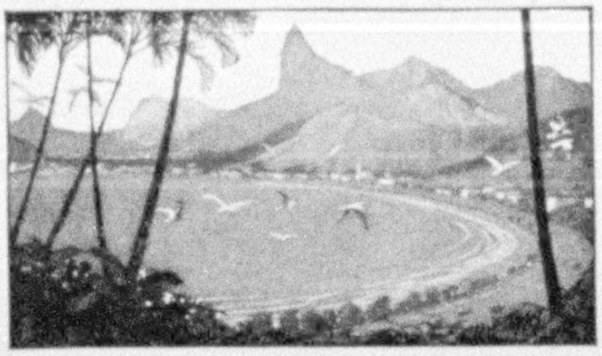
Take a motor trip through the high and lovely mountains of Dauphiny, where the little villages cling to the roof of the world, and the bells of the monasteries chime down the slopes, and the peasant children greet you with shy smiles and bunches of sweet lavender . . .

Go to Mont St. Michel for the thrill superb, and see that shining wonder across the long pale sands. Think of Duguesclin stalking the midnight streets of Rennes—and little Jeanne D'Arc meeting her king at Chinon.

Add this experience to the pleasure of your Atlantic crossing. Walk into France at the French Line gangplank in New York . . . at Havre, the port of Paris, just another gangplank . . . then the boat train—and in three hours you're in Paris. Easiest and by far the most enjoyable way to make such a trip . . .

French Line

Compagnie Générale Transatlantique, 19 State St., New York
Offices and Agencies in Principal Cities of Europe and the United States



It's Summer Now in South America

WHY not enjoy a delightful voyage to the warm, sunny wonderlands below the equator? Tall palms, flowering trees, strange plants—a land radiantly beautiful under smiling tropical skies. The Pan America Line will take you directly to the most interesting places. Rio—a city all unique—gleaming blue seas—romantic gardens and drives—charming hotels on the heights of Gloria and Santa Theresa. See Montevideo and its beach resorts. Visit brilliant Buenos Aires, the Paris of the western world.

Send the coupon now and learn about this ideal winter trip. Every modern comfort for tropical travel is provided on the four white sister ships. These U. S. Government vessels are the finest and fastest between New York, Rio de Janeiro, Santos, Montevideo and Buenos Aires. Regular fortnightly sailings with Rio less than 12 days away. Get all the facts now. Clip the coupon.

PAN AMERICA LINE
Operated for
U. S. SHIPPING BOARD
by Munson Steamship Line, *Managing Operators*
67 Wall Street New York City
or your local agent

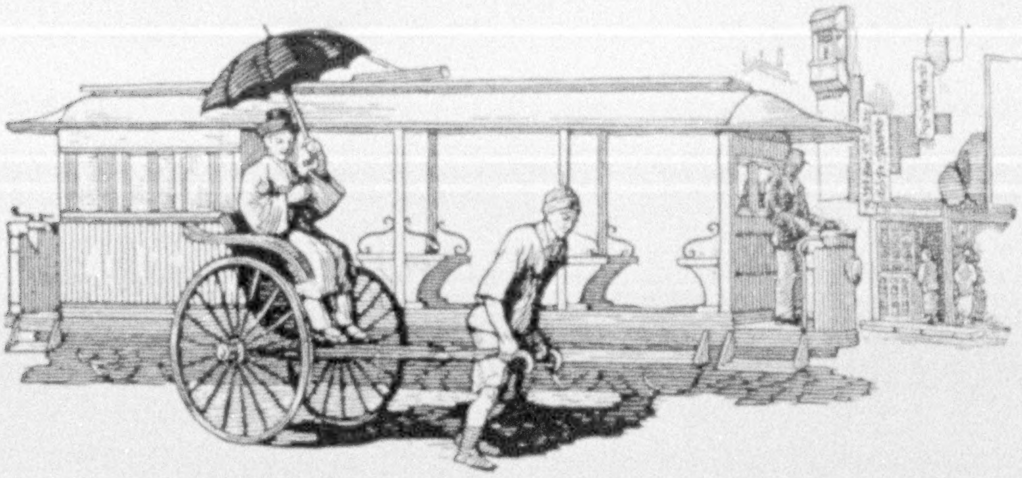
To U. S. SHIPPING BOARD
Infor. Desk 1551 Washington, D. C.

Please send the new illustrated booklets giving travel facts about South America and full information about the ships of the Pan America Line. If I go, date will be about________ There will be______ in my party.

Name ________________

Address ________________

Town__________ State __________



Asia Goes to Market

Change works fast in the Orient!

There are trolley cars in Pekin. There are telephones in Tokio. In Hong Kong houses and streets are electrically lighted. The 'rickshaw is giving way to the automobile.

Chinamen are eating American breakfast cereals. They are smoking American cigarettes.

And now comes news that a new chewing gum has been created especially for the Chinese trade.

Asia, once looked upon as just a place from which to import silks and curios, has gone to market.

In eight years China jumped from twenty-eighth to fifth place among world buyers of American goods. In ten, Japanese imports increased threefold.

The Dutch East Indies, the Malay States, British India, Chosen, Siberia, Australia and the Philippines are eager for a chance to trade.

Across the Pacific lie three-quarters of the world's people, white men, black men, yellow men and brown men.

Year by year their buying power grows. Year by year they look more and more to America for manufactured goods of all kinds.

A commerce destined to become the greatest in all history, already amounting to hundreds of millions annually, is to be the heritage of certain youthful cities in the Pacific Northwest.

And the names of these youthful cities, looking hopefully westward across the highway of this commerce, are Seattle, Portland, Tacoma, Astoria, Vancouver, Bellingham, Everett, Bremerton, Port Angeles, Gray's Harbor, Aberdeen, Hoquiam and Anacortes.

They are the ports of Washington and Oregon. They are the natural outlets for American trade with the Orient. For they are nearer by several days' sailing than the ports of California to the chief points of Asia and the islands of the Pacific. They are nearer by rail to the Atlantic Seaboard. They are endowed with harbor facilities unparalleled on our Atlantic Coast.

And the Pacific Northwest, of which they are the commercial capitals, the states of Washington, Oregon, Montana, Idaho and Wyoming, has tremendous industrial resources—half the potential water power of the United States, half its standing timber, billions in foods, metals, coal and oil—to support this commerce.

American industrial enterprise is reaching westward, for in the Pacific Northwest it sees its greatest opportunity *now!*

Table of exports from the United States, showing proportion sent to the Orient of the articles listed

(Based on 1922 figures of the Far Eastern Division, U. S. Department of Commerce)

Cigarettes	99%
Wire nails	67%
Textile machinery	63%
Rails	61%
Transmission equipment	59%
Power and other transformers	59%
Generators	51%
Illuminating oil	47%
Sewing machines	37%
Construction machinery	37%
Motorcycles	36%
Motors	35%
Motor trucks	33%
Metal-working machinery	29%
Automobiles	27%
Structural steel	25%
Tires	22%

The Pacific Northwest

The Chicago Burlington & Quincy R·R·
The Great Northern Ry·
The Northern Pacific Ry·

Northern Pacific · Burlington Route · Great Northern

CUNARD
AND THE
WEST INDIES

All the comfort and luxury of Cunard ocean travel — the renowned accommodations, equipment, cuisine and service — may be enjoyed on two delightful *thirty-day*

Caribbean Cruises
sailing from New York
Jan. 22 and Feb. 24, 1925

on the S. S.

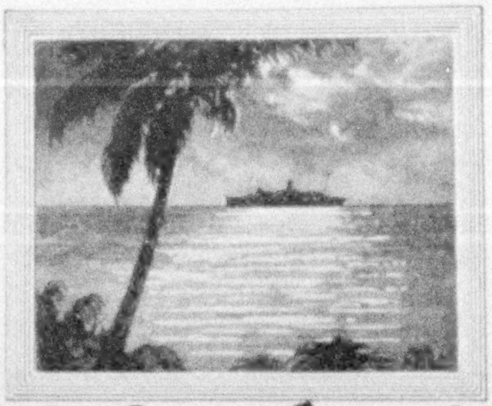
Tuscania
of the Cunard and Anchor Lines.

Itinerary includes Havana, Kingston, Colon, Cartagena, Curacao, La Guayra, Port of Spain, Barbados, Martinique, St. Thomas, San Juan, Nassau, Bermuda.

To EGYPT and the MEDITERRANEAN
S. S. MAURETANIA, Feb. 17, 1925

CUNARD
and ANCHOR *Lines*

NEW YORK
25 Broadway — or Branches and Agencies



Winter Cruises

WEST INDIES

January 22nd — *February 23rd*

TWO cruises to the romantic Carribbean by the magnificent ORCA, 25,500 tons displacement. Each cruise 29 days. Extensive itinerary. Shore excursions. Rates $250. up.

BERMUDA

"The Sportsman's Paradise" — golf, tennis, bathing, etc. — only 48 hours from New York. Weekly sailings by the palatial transatlantic liner ARAGUAYA. Rates $70 up.

Write for illustrated booklets

"The Comfort Route"

ROYAL MAIL

THE ROYAL MAIL STEAM PACKET COMPANY
New York · Boston · Pittsburgh · Chicago · Detroit

The Hotel
BERMUDIANA

One of the world's most splendidly equipped and furnished hotels. The newest and most modern in Bermuda —built of steel and stone entirely fireproof. Opens Jan. 16.

For booklet, write John O. Evans Manager, The Hotel Bermudiana Hamilton Bermuda, or Furness Bermuda Line, Desk "B" 34 Whitehall Street New York.

GATES TOURS to EUROPE

30 to 80 days—$450 and up. Sailings March to August. Gates Tours are planned and managed by skilled experts with over 30 years of travel experience.

Be sure you get OUR booklet, "How to see Europe at Moderate Cost," before deciding on your European tour. It's FREE. Write for 1925 Booklet A-1.

GATES TOURS—Founded 1892
European Travel at Moderate Cost

225 Fifth Avenue, New York
London · Paris · Rome

Why 460 000 people have *moved* to California in Five Years

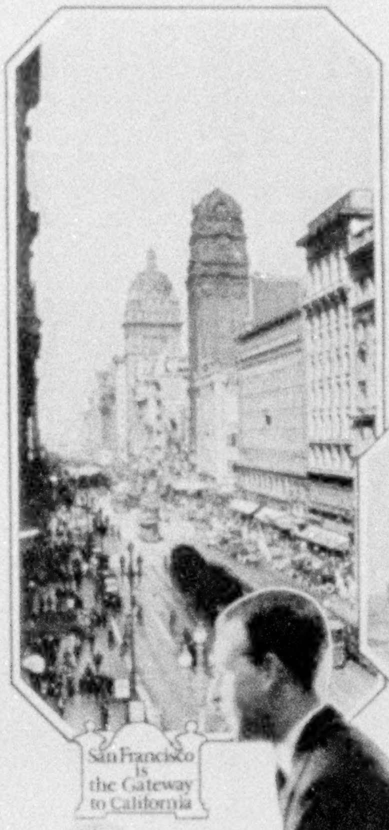
THE PLACE to succeed is where others succeed.

In every Central California city and county are people like you—who, with moderate resources, have succeeded better and are happier here. They know it, they say so, their bank books show it. All year 'round their roses bloom, their crops ripen, their children play out of doors. Forty-four thousand miles of improved highways tie city and country together. The heart and center of all this business, industrial and agricultural life is San Francisco—a city that leads all American cities in per capita wealth.

"Where Life Is Better"

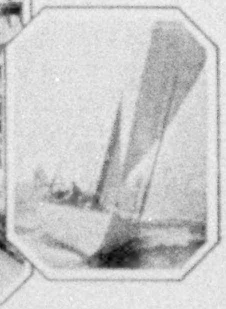
What do you desire from life? Californians have twice the bank deposits of the average American. They spend more, save more, live better. The reason? Greater opportunity for people with a moderate nest egg to get ahead!

If you can succeed and save money where you are, by all means find out what California can do for you. More than 240,000 people already have written to Californians Inc., a non-profit organization devoted to the sound development of the State, and have received the illustrated, authoritative free booklet, "California, Where Life Is Better." That it may lead you to greater material success, greater opportunity, greater enjoyment of life, write today for this booklet. Fill out the coupon and mail it to Californians Inc., San Francisco, Calif.



San Francisco is the Gateway to California

San Francisco, "the city loved around the world" is the commercial and industrial capital of California.



"Where Life Is Better" —a California vista— near San Francisco.

They came, they saw, they stayed

How thousands of newcomers feel about life in California—excerpts from letters to Californians Inc.

"I have been here since last December. The wonders and beauties as well as the business advantages of this part of the state cannot be overstated."—H. K. H., *San Francisco.*

"I am making more money on fifteen acres of olives and fruit here than I did on 640 acres where I came from."—H. W. H., *Corning.*

"In 1919 we bought our present place, 50 acres of bare land and planted it to fruit. We have one of the show places in this district.

"Our land has increased in value each year an amount equal to the original purchase price and is still increasing. Every dollar for improvements we have made right here."—H. M. L. and Family, *Ripon.*

MAIL *this coupon for* FREE BOOKLET *about life in California*

Californians Inc.

Headquarters
SAN FRANCISCO

140 MONTGOMERY STREET, ROOM 500

Please send me "California, Where Life is Better"

Name ______________________

Str. City & State ______________________

Hawaii

Laughs at Winter

Get out the steamer trunk, pack plenty of summer clothes, phone your nearest railway, travel or steamship agent for a ticket direct to Hawaii—and laugh with us at winter!

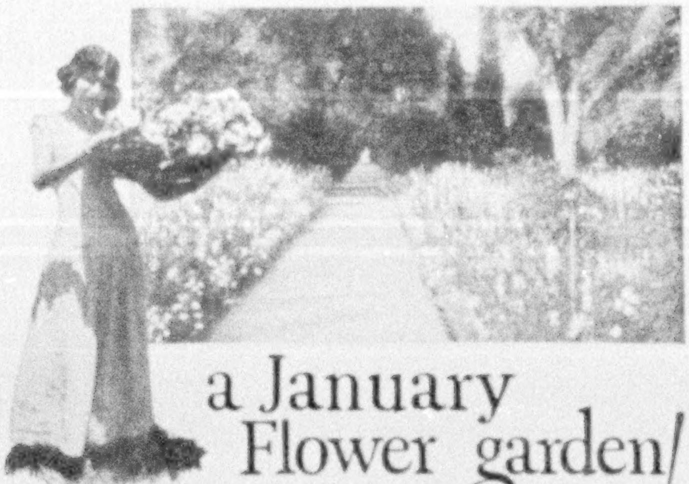
In 2 weeks or less you'll be splashing in Waikiki's voluptuous surf; playing, resting, dreaming in the land of tropic flowers and soft sunshine.

Golf, tennis, swimming, surfing, deep-sea fishing, inter-island cruising—all outdoor sports in this lovely territory of the United States. Volcanic spectacles in Hawaii National Park. Ample modern hotels.

United States battle fleet will maneuver here next April, May and June. Make steamer and hotel reservations NOW if you would visit the Islands then. Round trip may be made in 3 to 4 weeks from San Francisco, Los Angeles, Seattle, Vancouver or Victoria, B. C., allowing one or two weeks in Hawaii, for $300 or $400, covering all necessary expense.

For full information with illustrated brochure in colors, WRITE NOW—

HAWAII TOURIST BUREAU
212 Monadnock Building, San Francisco
or 341 Fort St., Honolulu, Hawaii, U. S. A.



a January Flower garden!

Phoenix
ARIZONA

...Roses, sweet peas, sweet alyssum, oleanders—flowers everywhere—blooming in Phoenix, *now*.

No frost, no snow, no fog nor cold, biting winds—just sunshine and verdure all winter long, and we want to share them with you.

Come to Phoenix, *now*—come direct or stopover en route to the Pacific Coast. Down here the air is like June, and all outdoors calls. We are golfing every day, *now*, and fishing, and hunting. Why not come—to America's Winter Paradise?

Come and picnic with us, to the mountains, or Roosevelt Dam, or to the Desert. Drive over the safe, scenic Apache Trail Highway—the thrill of a lifetime!

Write for free booklet TODAY—sent by return mail so you can decide to come this month. We'll make all arrangements—hotels, apartments, bungalows, etc.

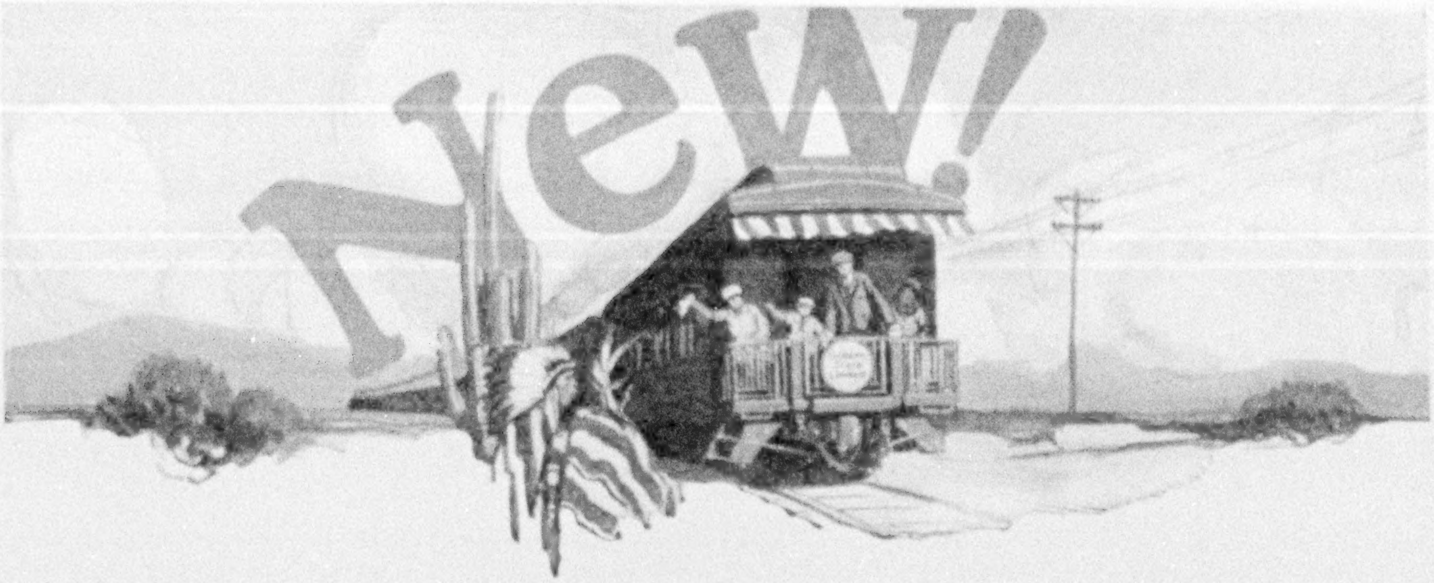
Stopovers on Southern Pacific and Santa Fe Railways. Winter tourist rates effective.

Phoenix-Arizona Club E
104 Chamber of Commerce Bldg., Phoenix, Ariz.
Please send my copy of "*Phoenix, Where Winter Never Comes*," by return mail.

Name ______

Street ______

City ______



fast luxurious service to

California

LOS ANGELES · SAN DIEGO · SANTA BARBARA

Commencing December 28th, 1924

Golden State Limited

A completely new, de luxe, all-Pullman train. Most modern sleeping, observation, club and through dining cars; lounging room for ladies, maid and manicure, two baths, barber, valet.

TWO OTHER FAST DAILY TRAINS—Coaches, tourist and standard sleepers, and dining cars. All trains leave Eastern terminals from Rock Island stations, and Western terminals from Southern Pacific stations—via GOLDEN STATE ROUTE—the short, interesting, mild-weather, low-altitude route.

For complete information, address office nearest to you

Commodious lounge room, dressing rooms, bath, manicure and maid

Club car, shower, barber, and valet. Telephones in terminals

Through dining cars, always ready to serve you meals of appetizing variety

Southern Pacific

LINES

New York, 165 Broadway   Chicago, Southern Pacific Bldg.   Tucson, Score Bldg.
El Paso, 206 North Oregon St.   Los Angeles, Pacific Electric Bldg.

SOUTHERN PACIFIC LINES

Golden State Route

from CHICAGO   ST. LOUIS   MINNEAPOLIS   ST. PAUL   KANSAS CITY

Little Mistakes In English Make Others Judge You Unfairly

You are sized up every day by what you say and write. The words you use, how you use them; your spelling, grammar, punctuation—these tell the measure of your ability, your experience, your breeding, more clearly than anything else. Your English says to all the world, "This is what I am!"

SHERWIN CODY

How Poor English Hurts You

English is the advertisement of your ability. Your language determines your position in the social and business scale. Charming personality, fine clothes, wonderful appearance, count for little if handicapped by imperfect or "sloppy" English.

People will think you are lacking in education and culture if you spell incorrectly such common words as "business," "abbreviate," etc.; if you say "between you and I" instead of "between you and me"; if you use "who" for "whom" and "shall" for "will." What can you expect people to think if you don't know when to use one or two "c's" or "m's" or "r's, "or when to use "ei" or "ie," or if you say "hosPITable" when you should say "HOSpitable"? Fairly or unfairly, everybody everywhere judges you the same way. Poor English is an unnecessary handicap.

15 Minutes a Day Perfects Your English

If your English does not make people think the best of you, then it must be improved. Extensive tests show that most men and women are but 61% efficient in the essential points of English.

But now there is a way to improve your English. Sherwin Cody, perhaps the best-known teacher of practical English, has perfected and patented a remarkable device which quickly gives you a commanding mastery of English. He has thrown aside all the "junk" which makes the old methods so inefficient. The drudgery of rules and tiresome drills is discarded. Each evening you are assigned an easy 15-minute lesson. No time is wasted on what you already know. You are quickly shown your mistakes in spelling, punctuation, grammar, and pronunciation, and you concentrate on the points that need attention. By actual use correct English soon becomes a habit.

FREE Book on English and 15-minute test

A command of polished and effective English denotes education and culture. It wins friends and makes a favorable impression upon those with whom you come in contact. In business as well as in social life, correct English gives you added advantages and better opportunities, while poor English handicaps you more than you will ever realize. And now, in only 15 minutes a day—in your own home—you can actually check up and see yourself improve by using the 100% self-correcting method.

If you are efficient in English, it will give you greater confidence; if you are deficient you surely want to know it. For this reason Mr. Cody has prepared a simple 15-minute test which you can take in your own home. The correct answers are given so you can tell at once just where you stand. Write today for this test—it is free. We will also gladly mail you our new free book, "How to Speak and Write Masterly English." Merely mail the coupon or a postal card. Free yourself of the embarrassing errors in English that make you feel ill at ease. You can never achieve your greatest possibilities until you master English. Write today.

Sherwin Cody School of English
381 Searle Bldg. Rochester, N. Y.

SHERWIN CODY SCHOOL OF ENGLISH,
381 Searle Building, Rochester, N. Y.

Please send me your new Free Book, "How to Speak and Write Masterly English," and also the 15-minute Test.

Name..

Address..

City.......................... State..............

NOW 43 YEARS

WITH the New Year, the record of S. W. STRAUS & Co. becomes "43 years without loss to any investor". This record, involving the distribution of hundreds of millions of dollars of safe securities, merits your attention, because it points the way to safe investment. We suggest that you investigate. Write today for

BOOKLET A-1508

S.W. STRAUS & CO.

Established 1882 Incorporated

STRAUS BUILDING
565 Fifth Avenue at 46th St.,
NEW YORK

STRAUS BUILDING
310 S. Michigan Ave. at Jackson Blvd.
CHICAGO

43 YEARS WITHOUT LOSS TO ANY INVESTOR

© 1925—S. W. S. & Co., Inc.

CLARK'S 5th CRUISE

AROUND THE WORLD

From N. Y. Jan. 20, by specially chartered New Cunard and Anchor oil-burning S. S. "California," 17,000 tons, including Havana, Panama Canal, Los Angeles, Hawaiian Islands, 18 days in Japan and China (Peking optional), Manila, Java, Singapore, Burmah, option 18 days in India, Cairo, Jerusalem, Athens, Naples, Riviera, with Europe stop-over.

4 MONTHS, $1250 up

Including Hotels, Drives, Guides, Fees, etc.
We expect to carry 600 to 700 passengers on each cruise.

CLARK'S 21st CRUISE, JAN. 31

TO THE MEDITERRANEAN

By specially chartered sumptuous new oil-burning S. S. "Laconia," 20,000 tons. 17 days in Egypt and Palestine; Spain, Athens, Rome, Constantinople, Riviera, etc. 62 days' cruise, $600 up, including Hotels, Guides, Drives, Fees, etc.

Norway and Western Mediterranean Cruise, July 1; 53 days, $550 up. Originator of Round the World Cruises. Longest experienced cruise management. Established 30 years.

FRANK C. CLARK, Times Bldg., New York

St. Petersburg

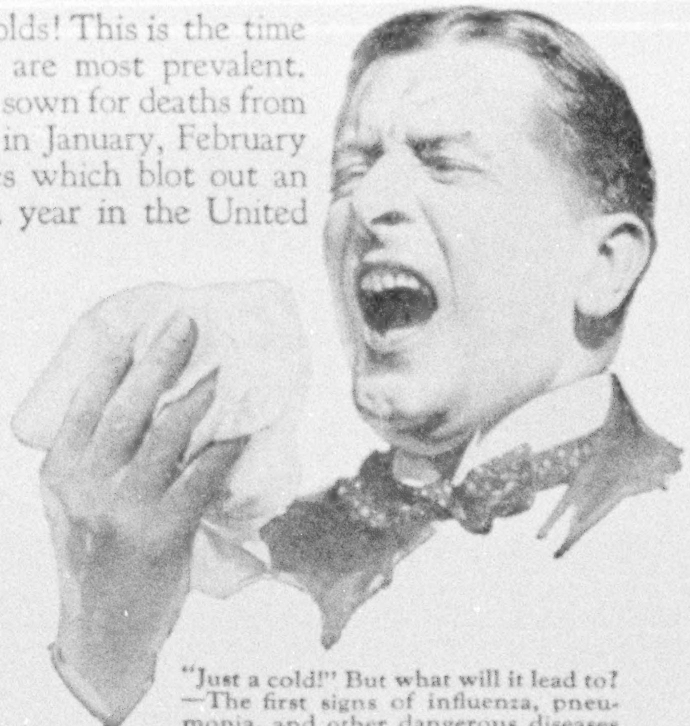
"The Sunshine City"

Famous for its balmy sunshine that has failed on only 75 days in 14 years. On Florida's West Coast. A playground colorful with flowers and palms—and the sparkling Bay and Gulf. Wonderful bathing, yachting, motoring. Great golf, fishing, tennis—every recreation for young and old. Sumptuous new hotels and accommodations of all kinds. Write for interesting booklet—ask any question.

Address M. B. Dillman
Chamber of Commerce
St. Petersburg, Florida

Fair Warning!

LOOK out for January colds! This is the time of year when colds are most prevalent. Seeds are now being sown for deaths from pneumonia that will occur in January, February and March. These diseases which blot out an average of 150,000 lives a year in the United States and Canada frequently develop from neglected colds. Out of every seven who get pneumonia one person dies. As many people die each year from pneumonia as from tuberculosis. Year after year the same thing happens.



"Just a cold!" But what will it lead to? —The first signs of influenza, pneumonia, and other dangerous diseases are often mistaken for "just a cold."

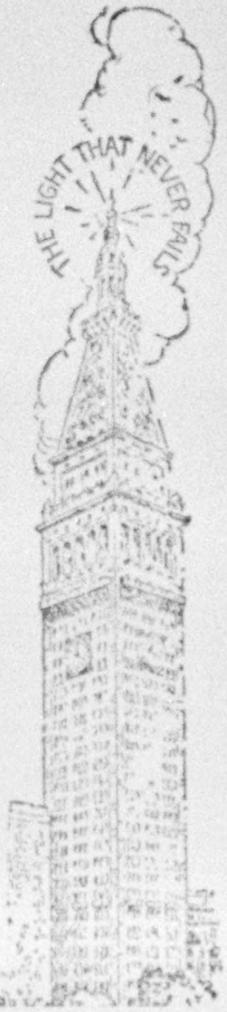
Do not neglect a cold. A cold in the head is not a simple, trifling annoyance but a real disease with a medical name—coryza. In addition to the danger that pneumonia may develop, a cold often leads to chronic catarrh of the nasal passages, to ear trouble ending in deafness, to chronic bronchitis and inflammation of the bony cavities of the face. A neglected cold may even prepare the way for serious heart trouble.

The first noticeable symptoms of diphtheria, typhoid fever, measles, scarlatina, whooping cough or smallpox may appear as a cold. A person suffering from what seems to be an innocent cold may pass on to someone else a fatal attack of one of these diseases. If you or your children are suffering from colds stay away from other people until you are certain that the "cold" is not an infectious disease. This decent precaution will prevent many serious epidemics and save many lives.

A cold is an inflammation of the mucous membrane which settles upon the point of least resistance—the nose, throat, chest, or gastro-intestinal tract. Sudden changes in temperature, drafts and exposure to damp and cold, breathing stale air and street dust—these are direct causes of colds.

Lack of fresh air and sufficient exercise to keep the skin and body healthy, lack of sleep and rest, over-indulgence in rich indigestible food—these are indirect causes of colds.

To take cold easily is to advertise that your living habits are wrong. By following simple health rules you are likely to keep well. But if in spite of all your care, you do take a cold—do not treat it lightly. See your doctor. Remember, it is not a sign of weakness but a mark of wisdom never to neglect a cold.



The amount of absenteeism in large business establishments is seldom realized until the facts are thoroughly reviewed. Common colds are among the chief sources of loss of time.

In a group of about 8,000 clerical employees of the Metropolitan Life Insurance Company at the Home Office, records show that colds which involve disability for work affect 2 out of every 5 employees during the course of a year.

Among school children, colds are probably the cause of more absenteeism than any other illness—with consequent falling back in grades and extra expense to the tax payer.

Medical supervision of schools is becoming more thorough from year to year and is doing much to prevent serious epidemics and thus save lives. Parents should cooperate with school authorities in working to stamp out these minor illnesses which frequently have fatal consequences.

The Metropolitan Life Insurance Company has prepared a pamphlet, "Prevention of Pneumonia" which will be mailed free to everyone interested in guarding against this dangerous disease which ranks second only to heart disease in the death rate. Send for it.

Permission is gladly given to any individual, organization or periodical to reprint this page wherever it may serve the interests of community welfare.

HALEY FISKE, *President.*

Published by

METROPOLITAN LIFE INSURANCE COMPANY—NEW YORK

Biggest in the World, More Assets, More Policyholders, More Insurance in force, More new Insurance each year

A new Victor product

The Music Arts Library of Victor Records

Just as a certain amount of reading is part of everybody's life experience, so too there is a proportionate amount of music with which every man and woman wishes to be familiar. That is the key-note of the Music Arts Library of Victor Records, six volumes of which are now ready. The Music Arts Library of Victor Records represents a great variety of achievement by the world's greatest artists, and provides a wholly new outlook on the collecting of recorded music. With one exception these volumes, finely bound, printed and illustrated, may be obtained for the price of the records contained in them. Ask the nearest dealer to show you the Library, or write to us for a descriptive circular.

TRADE MARK "HIS MASTER'S VOICE"

Real Victrolas are *marked* Victrola

TRADE MARK

Victrola

Victor Talking Machine Company, Camden, N. J.

Victor Talking Machine Co. of Canada, Ltd., Montreal

Canadian price-list on request

One of the volumes of The Music Arts Library of Victor Records

Six volumes now ready

Victrola No. 370 Mahogany, $275; electric, $315

Vol. XLVII, No. 1 WASHINGTON January, 1925

THE NATIONAL GEOGRAPHIC MAGAZINE

COPYRIGHT, 1924, BY NATIONAL GEOGRAPHIC SOCIETY, WASHINGTON, D. C., IN THE UNITED STATES AND GREAT BRITAIN

SEEING AMERICA FROM THE "SHENANDOAH"

An Account of the Record-making 9,000-mile Flight from the Atlantic to the Pacific Coast and Return in the Navy's American-built, American-manned Airship

By Junius B. Wood

Author of "The Far Eastern Republic," "Yap and Other Pacific Islands under Japanese Mandate," and "A Visit to Three Arab Kingdoms," in the National Geographic Magazine

On the morning of October 7 last the big Navy airship, U. S. S. *Shenandoah,* was starting from Lakehurst, New Jersey, on its record-making cruise of more than 9,000 miles, twice over the Rockies and twice around three sides of the United States.

The autumn sun was peeping over the horizon at 5:35 a. m., as the *Shenandoah* was led out of the big hangar. Every man on the station helped, 300 of them—sailors, marines, Filipino mess boys, and civilians. They came running into the drear, misty morn like little ants pulling an immense gray worm out of its nest. The run slackened to a walk when she was safely clear of the shed.

Nose to the wind, she was led farther into the field toward the mast, the crew stumbling and slipping in the loose sand. They stopped and waited.

MOORED TO THE MAST, READY FOR THE START

The sun's rays were warming the cells in the big tube and the gas was expanding like a morning-glory. The ship tugged to rise higher. The men braced themselves, held and led her closer to the mast.

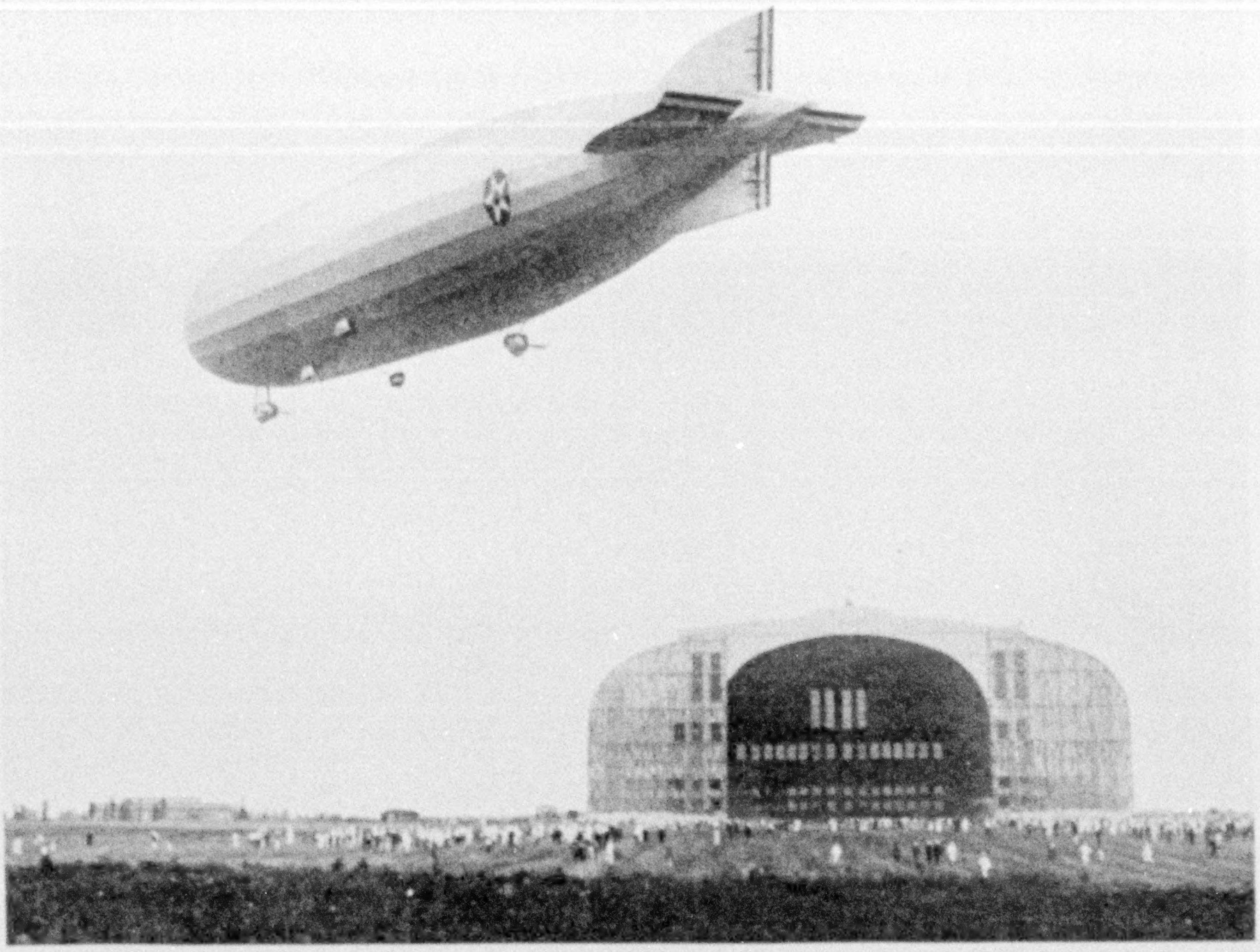
A long cable dropped from the ship and was hooked to its mate, trailing on the ground from the mooring mast. A winch rumbled and the big, docile craft was pulled down until the swivel pear on its nose nestled into the cup on the tower. It was moored. That was at 7 a. m., and all hands stopped for breakfast.

At 10 o'clock the ship was ready to cast off. During the three hours, the sun had been warming the helium gas as if it were in a hothouse. With each degree that its temperature rose above that of the surrounding air, the ship was lifting another 300 pounds. More fuel, more supplies, and more officers and men had gone aboard, one by one and each to a particular spot in the long keel tunnel.

While the ship's nose rests on the mast, the delicate balance must be maintained. With a mast only 160 feet high and a big tube 682 feet long, not many degrees' drop is possible before the tail fins scrape the ground.

The earth was beginning to radiate the heat of the sun. The start must be made while the ship held its handicap of superheat. The little elevator in the mast had brought up its last passenger. The fuel was being piped on in driblets, valves

XUM



Photograph by Pacific and Atlantic

THE "SHENANDOAH" LEAVES LAKEHURST FOR A TEST FLIGHT

The initial flight of the Navy's great aircraft was made on September 4, 1923, covering 40 miles in about one hour. Ease in handling the ship at low speeds—an important feature of rigid airship performance—was demonstrated. This was the first time in the history of aviation that a rigid airship was flown when inflated with the noninflammable helium gas.

opening and shutting, holding her down with a few more pounds every time she strained to go higher.

Lieutenant Commander Zachary Lansdowne, the captain, had gone aboard. Usually he was next to the last to leave the mast. After him came the mooring officer, who closed the gangway after him, making it part of the ship's well-rounded nose. This time the ship's sole civilian passenger was later than the captain.

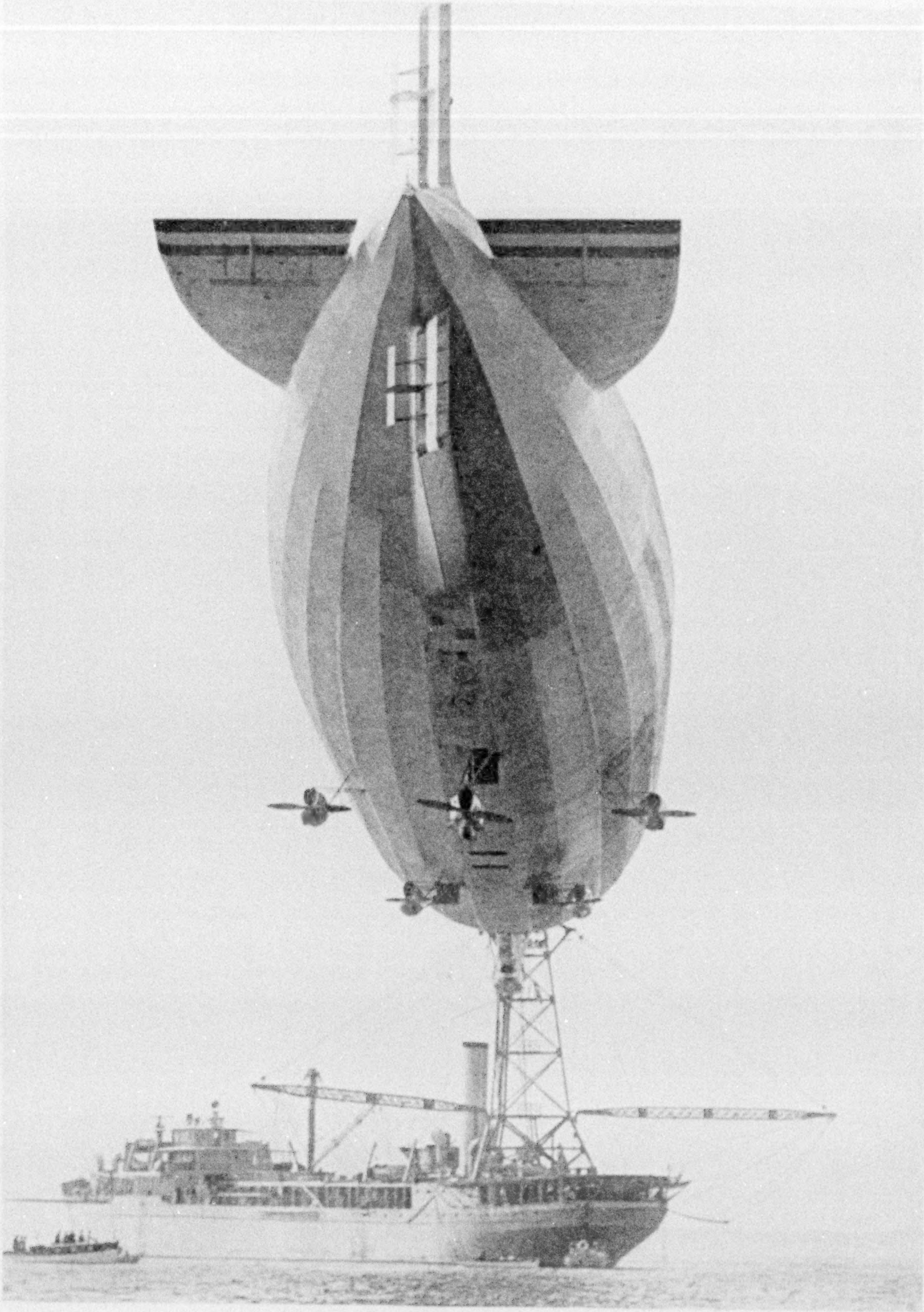
"Ahoy, control car! Mr. Wood is waiting to come aboard, sir," a chief petty officer on the mast shouted through a megaphone.

"Tell Mr. Wood to stand by," the officer of the deck had megaphoned back.

Each one, as he came to the top of the mast, had asked permission from the "bridge" before he had stepped on to the little gangway. At times the ship was buoyant enough to take him. Others had been ordered to "stand by." In a few minutes the ship would grow lighter, and the order would come for one more to step aboard. That meant only minutes for them, for it was certain that they were going. It meant more for the passenger. Weight in fuel took precedence over passenger cargo. If enough "lift" remained after the required amount of gasoline was aboard, the passenger was going; otherwise, no passenger.

AN ANXIOUS MOMENT

To be all ready for a cruise into the great unknown, to get within one step of it, and then, perhaps, to get no farther, provides an anxious moment. Though the possibility had been anticipated, it was no less critical when it arrived. Personal baggage was limited to six pounds. A pair of socks, a suit of underwear, two handkerchiefs, a towel and cake of soap,

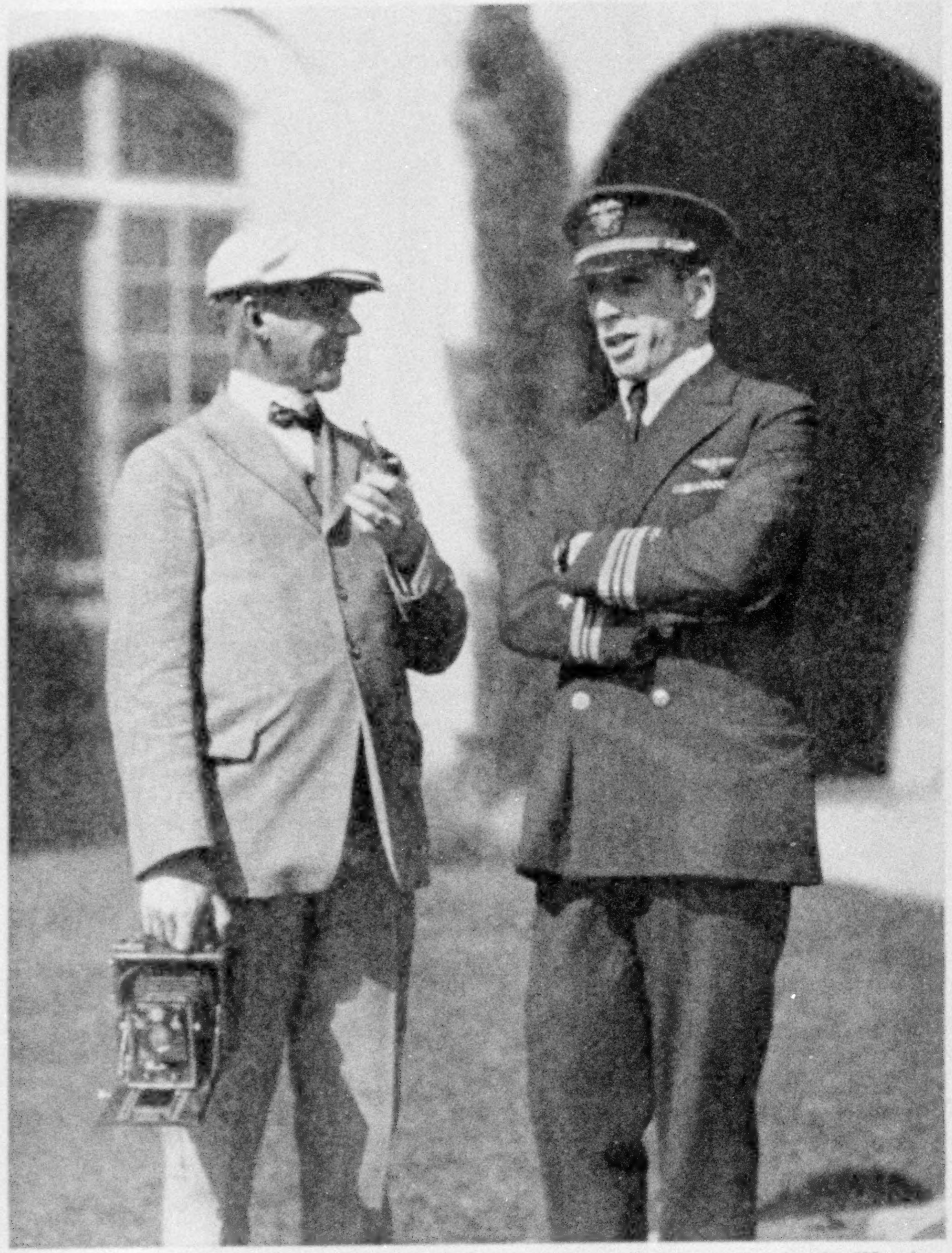


Official Photograph, U. S. Navy

AT THE MOORING MAST OF THE U. S. S. "PATOKA"

On August 8, 1924, the *Shenandoah* was made fast to the mooring mast in the stern of the airship tender *Patoka*, in Narragansett Bay, and thereby became the first airship in the world to moor to a floating ship. An additional test was made when the tender steamed 3 miles to a station off Middletown Beach, while the *Shenandoah* trailed astern without any perceptible swaying or plunging.

XUM



Photograph from Junius B. Wood

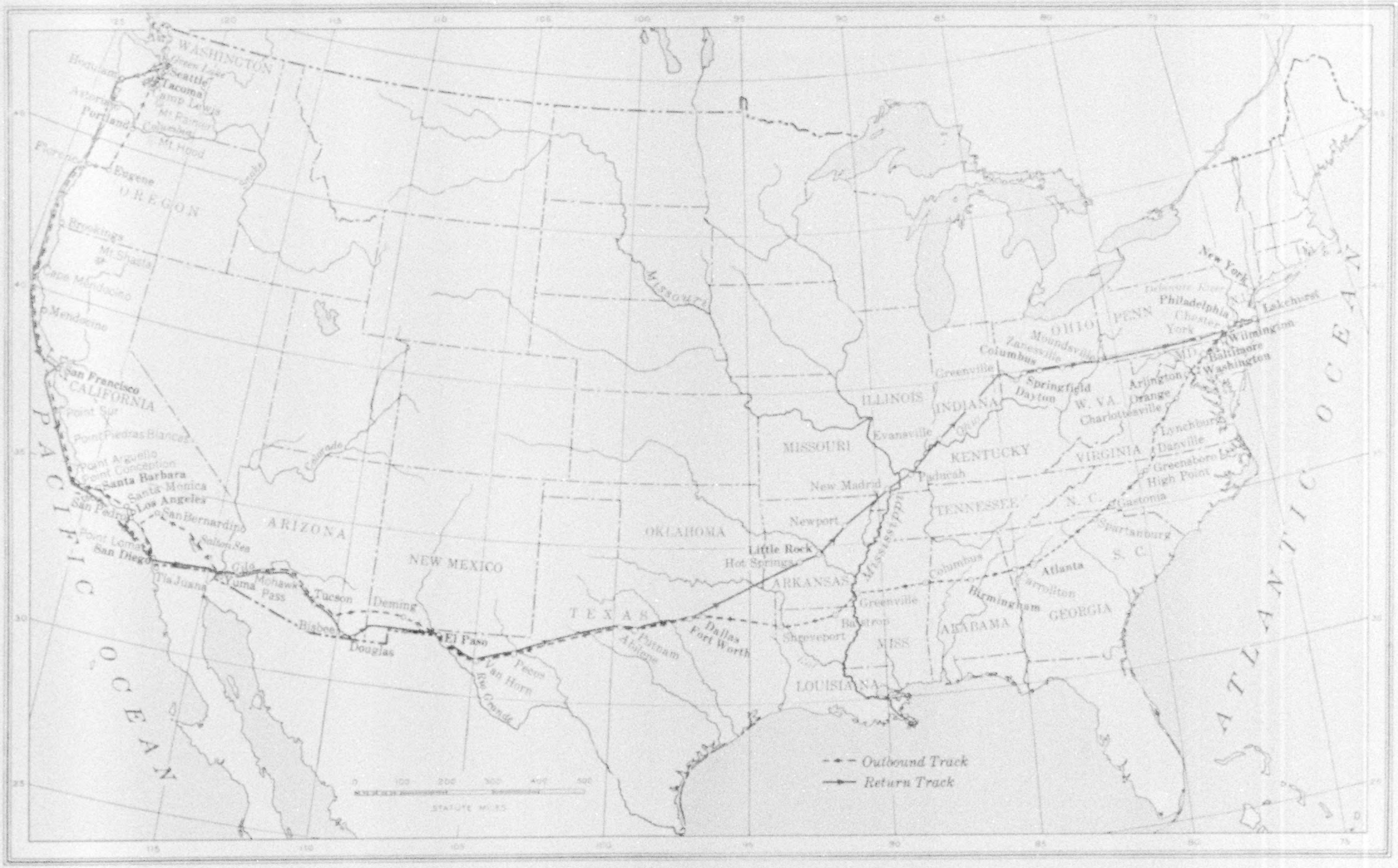
THE AUTHOR CHATS WITH COMMANDER LANSDOWNE

"Lansdowne is one of the type who foresees difficulties and does not get excited, but deftly and quietly avoids them" (see text, page 7). Mr. Wood had to discard his pipe, as smoking is not permitted on board.

Photograph by International

THE COMMANDER ON THE GANGPLANK OF HIS SHIP

Concealed in a door under the ship's nose, the gangplank leads to the 9-inch-wide runway, or "cat's walk," which occupies the center of the long keel, from nose to tail fins (see diagram, page 8).



THE TRANSCONTINENTAL ROUTES OF THE "SHENANDOAH" ON ITS RECORD-MAKING VOYAGE

The American-built, American-manned airship, having on board Rear Admiral William A. Moffett, chief of the Navy's Bureau of Aëronautics, a personnel of 11 officers and 27 men, and the author as the sole civilian observer, sailed from Lakehurst, New Jersey, at 10 o'clock on the morning of October 7. After a voyage of more than 9,000 miles, the giant craft returned to its airport of debarkation and anchored safely at 11:55 p. m., October 25.

Official Photograph, U. S. Navy

REAR ADMIRAL MOFFETT (IN THE REAR) AND LIEUTENANT COMMANDER LANSDOWNE IN THE NAVIGATING GONDOLA

Admiral Moffett has been the leading advocate of the practicability of the helium-filled airship for passenger traffic and exploration, claiming that the use of helium eliminates the danger of explosion, and the invention of the mooring mast on land and on convoy ships has simplified the difficult problem of airship terminals.

and an expurgated assortment of toilet articles had replaced a wardrobe trunk. A typewriter had gone aboard as ship equipment.

The Navy has orders against everything; also ways of doing everything without violating orders. The clothing problem was solved by wearing two lightweight instead of one heavy suit. On warm days one suit could be peeled snakelike. A fur-lined flying suit, mittens, and boots were ship stores.

"Tell Mr. Wood to come aboard," came the order after a minute which seemed an hour.

"Glad to see you aboard," said Lieutenant Charles E. Bauch, assistant keel officer, in real ship greeting. His tall form stooped in the narrowing forward end of the tube. He waved a hand in the general direction of the dim aft.

"The captain says to go down the ladder into the control car," he said. "Leave your kit here until we get under way."

To the person who has lived a lifetime with his feet never more than a few inches from the ground or from a structure in close contact with Mother Earth, the mere idea of soaring through the air seems the great feat, overshadowing all other details. To the aviator, at home in the air and in high altitudes, the working of his motors is the ever-present consideration. To the lighter-than-air navigator come all these problems and the greater one of the buoyancy of his craft.

While in motion, the engines and the horizontal rudders, called "elevators," can aid in holding it aloft. When stationary, they are of no assistance. The gas alone must lift the load.

Sailing several thousand feet in the air

Photograph by Junius B. Wood

IN THE "BRIDGE," OR NAVIGATING GONDOLA

Lieutenant Commander Lewis Hancock, Jr., the executive and navigating officer, is plotting the course; Lieutenant John B. Lawrence holds the steering wheel; and Chief Petty Officer F. J. Tobin grasps the wheel which controls the "elevators," or horizontal rudders. The radio "shack," in reality a separate gondola, is so close to the forward navigating gondola that, from the outside, it appears to be the tail end of the latter (see text, page 32).

is comparatively simple. Making a landing and casting off are the difficult parts of airship navigation. It is somewhat like docking a ship, only for the more delicate airship there can be no crunching of fenders or rubbing of piers by steel hulls.

THE CRITICAL OPERATION OF CASTING OFF

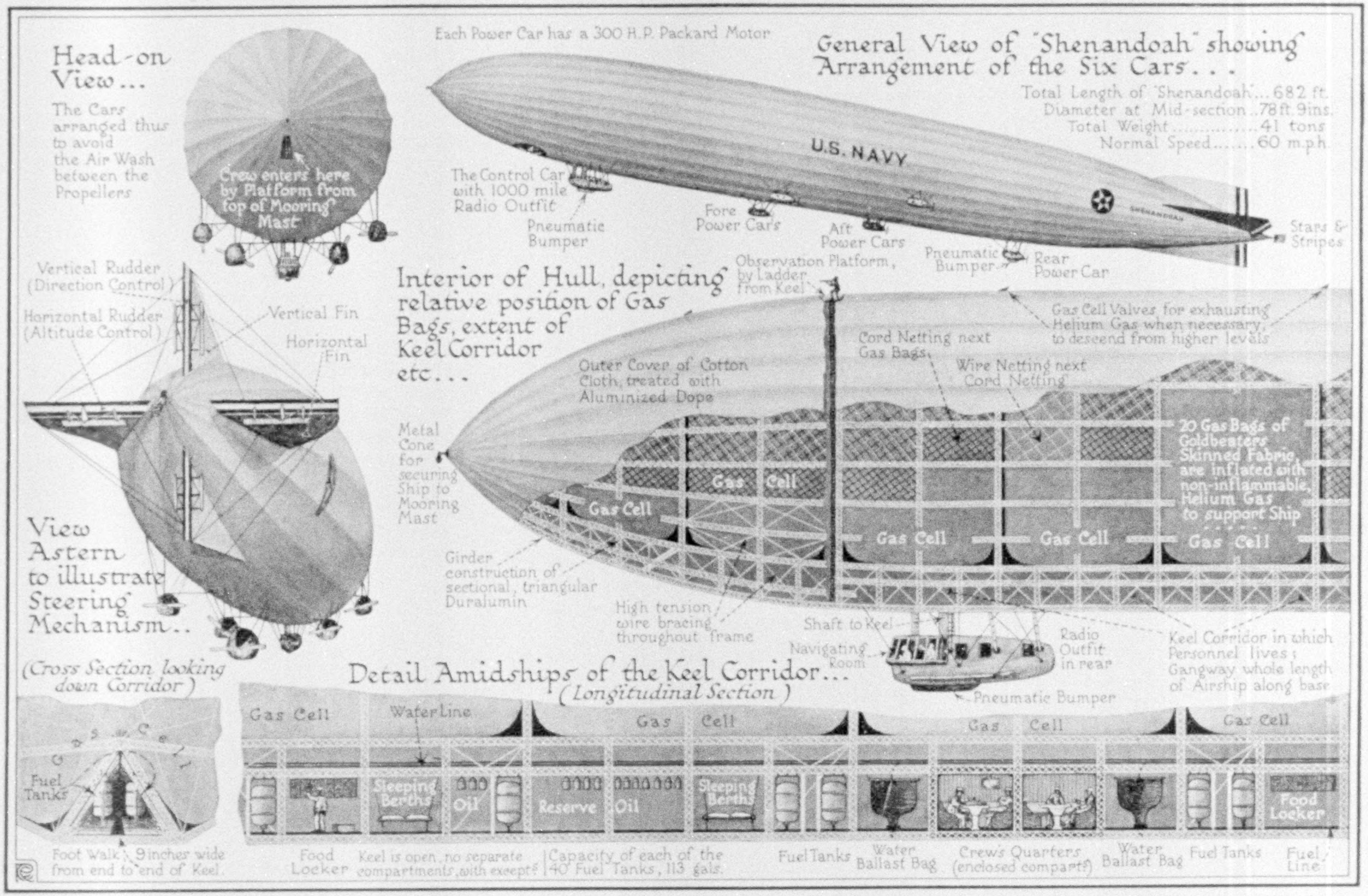
No one who is not needed is on the "bridge," the forward navigating gondola, during those critical operations. The others are at their designated "landing stations" or being shifted back and forth along the keel, human plummets, to keep the long tube balanced. Water is dropped in spurts of hundreds of pounds when the ship is heavy. In an emergency, even a gasoline tank may go. Men are shifted again to keep the balance. The ship must rise when it casts off, only for a few seconds, until the propellers have caught hold, but enough to clear the mast, which would cut its thin sides like a knife.

Rear Admiral William A. Moffett, chief of the Navy Bureau of Aëronautics, was in the rear of the little cabin as I squeezed down the ladder. I was the only passenger until the mountains had been crossed and San Diego reached.

Casting off from a mast is much the same, wherever the location. The day in San Diego, October 22, had all the picturesque features and its story illustrates the intricacies and skill involved in the operation of one of these giant ships of the air.

Lieutenant Commander Lansdowne sat in one of the forward windows of the gondola. Lansdowne is one of the type who foresees difficulties and does not get excited, but deftly and quietly avoids them.

Lieutenant Commander Lewis Hancock, Jr., executive officer and navigator, was close by; Lieutenant John B. Lawrence held the steering wheel; Lieutenant A. R. Houghton was officer of the deck,



© National Geographic Society

Drawn by Charles E. Riddiford

A PICTORIAL DIAGRAM OF THE SHIP THAT MADE THE HISTORIC FLIGHT

Note especially the "cat's walk," in the lower left corner. This narrow, railing-less plank is the only means by which the officers and crew can go from one end of the airship to the other. The thin cotton covering, 12 inches below, gives a false sense of security; the ground, usually 3,000 feet down, is only two steps removed. On the return voyage from the Pacific coast, one man made the first "step," as a stitched rent in the cloth shows (see text, page 23). At night the "cat's walk" is unlighted.

© Underwood & Underwood

SAYING FAREWELL TO THE WHITE HOUSE

On its flight to the Pacific, the big aircraft passed between the Washington Monument and the White House at 2:10 p. m., four hours after leaving Lakehurst, New Jersey. The White House is in the left foreground, and, just beyond it, the Treasury. In the right background, Pennsylvania Avenue stretches to the Capitol, dimly seen in the distance.

Photograph by Pacific and Atlantic

SALUTING THE UNITED STATES CAPITOL

On its memorable first visit to Washington, D. C., the *Shenandoah* flew over the Capitol, dropped flowers on the grave of the Unknown Soldier at Arlington, then proceeded to Mount Vernon to salute the tomb of Washington. Since that time, this airship has become America's best-known vehicle, for hundreds of thousands of spectators have watched its silvery form as it cruised back and forth across the continent.

with hands and eyes on the network of handles which empty ballast bags, and Chief Petty Officer L. E. Allenly was at the wheel of the "elevators," or horizontal rudders.

"We must weigh off right away, before we start to lose our superheat," Captain Lansdowne announces.

"Can tell from the mast that we're heavy aft, sir," Allenly reports.

"What water can we drop?" Lansdowne demands.

"We have three emergency bags aft and two forward," Lieutenant Houghton replies.

"You can drop any in the afterpart, sir," says Lieutenant Roland G. Mayer, keel officer.

"What's at frame 40?" Lansdowne asks.

"Four hundred pounds extra at 40, sir," Mayer replies.

"Clear away aft," Lansdowne orders through his little megaphone.

"Are we light?" asks Lieutenant Lawrence. Nobody answers.

"Still putting oil aboard, sir," comes a voice from the mast.

"Idle engines," Lansdowne orders in a sort of resigned voice. The few extra pounds of fuel must be crowded aboard.

"Idle engines, sir," echoes Lieutenant E. W. Sheppard, the engineer officer, holding the signal levers.

The dials are the same as on the bridge of a ship, but there is a lever for each engine in the five separate gondolas. Sheppard swings two handfuls of levers with one motion. The bells ring and repeat as the levers fly back and the men in the gondolas acknowledge the signal.

"Ship at least 300 pounds light," says the mast. "Last fuel coming aboard, sir."

"Very well; shut off fuel," Lansdowne

Photograph by Pacific and Atlantic

THE NIGHT ARRIVAL AT FORT WORTH, TEXAS

The airship reached its mast at Fort Worth at 8:30 p. m., October 8, but an hour elapsed before it cooled sufficiently to approach low enough to drop its cable (see text, page 26). Fort Worth is the home of helium gas, noninflammable and nonpoisonous, of which the United States possesses the only known source of considerable supply. It is extracted from natural gas (p. 98).

assents. "Secure the water line up there," he adds in a louder voice.

"Aye, aye, sir," the mast replies.

"We're now falling off to the right," says Lieutenant Lawrence, at the steering wheel. Four minutes have been consumed in the jockeying.

"How's the ship?" Lansdowne demands from an officer on the top of the mast.

"Still heavy, sir."

"Let me know when she's light," in a nonchalant voice. Everybody waits quietly; no strain; the ship will rise; only patience is required.

"Elevators neutral, sir," Commander Hancock announces.

"Neutral, sir," Allenly echoes. That means the ship is in equilibrium.

"A cloud is coming over the ship," Houghton announces.

"We'll have the sun again in a few minutes," Lansdowne adds, as if to himself.

"Are all hands on their landing stations?" he suddenly asks.

"On their stations, sir," Commander Hancock reports.

"She's coming up now, captain," from the mast.

No more questions; no more conversation. Two more minutes have gone.

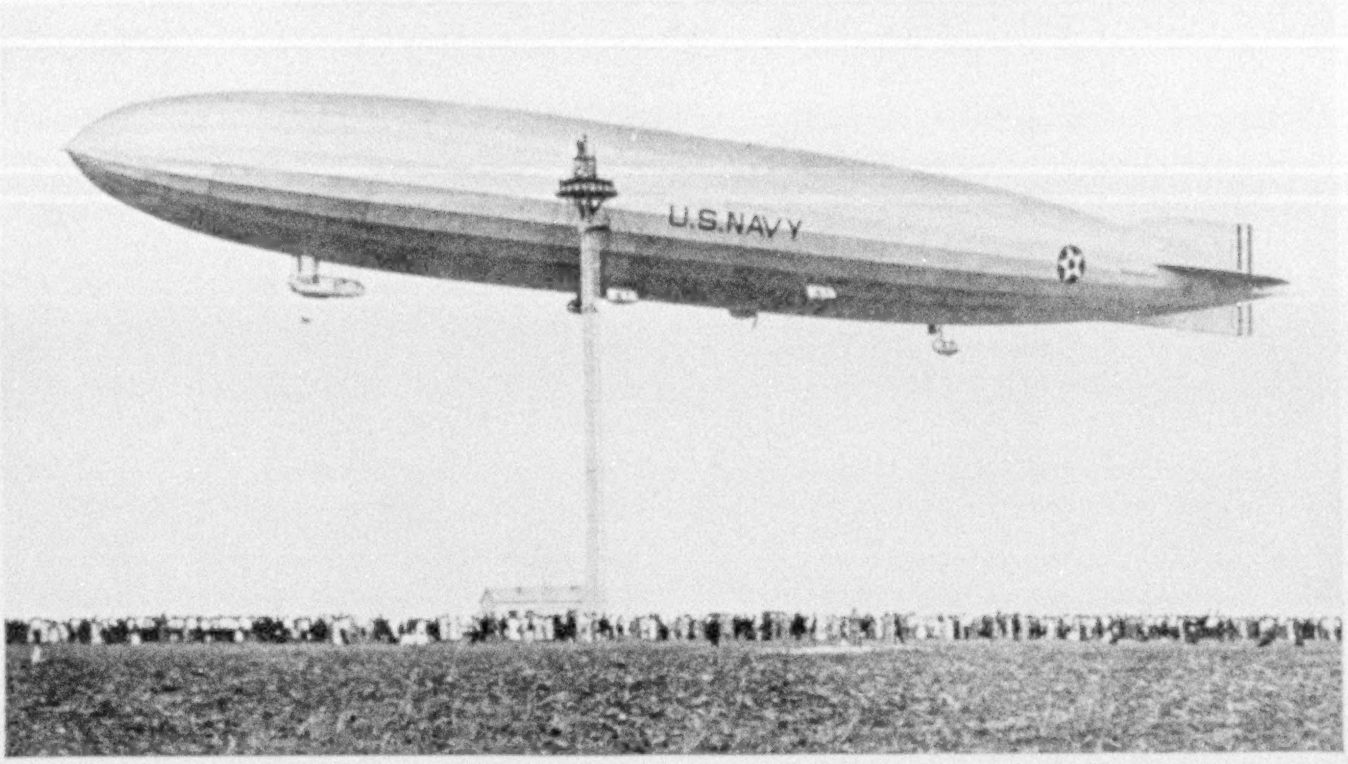
"Have an inversion of temperature aloft," the voice from the mast breaks the silence. It is a warning that the ship's buoyance will change as soon as she rises.

"Thank you," replies Lansdowne. "How high?"

"Only up to 2,000 feet."

"How many degrees? Considerable?" Lieutenant Lawrence inquires.

Lansdowne repeats the question. It is not answered. No time. The cloud has passed. The ship is picking up as the sun strikes it again. An opportunity may come in the tick of a second when she can slip away from the mast.



Photograph by Pacific and Atlantic

LEAVING FORT WORTH

"This big airship is in reality a flying laboratory, which by its construction and operation is developing not only a new element in the national defense, but is testing the efficiency and adaptability of allied industries which in time will become of extreme importance in the utilization of air navigation as a commercial enterprise."—*Lieutenant Commander Lansdowne.*

"Is the ship light?" Lansdowne asks.

"Not yet, sir," the mast replies.

"Is her nose secure? Is Rosendahl aboard?" he asks in a single breath.

"Yes, sir; she's just about in equilibrium," Lieutenant C. E. Rosendahl replies, without regard to sequence, as he comes down the ladder.

"Let me know the minute she is light," Lansdowne requests.

"About equilibrium," the mast replies.

"Let go as soon as she will lift out of the cone," he orders.

"Stand by the water for emergency aft," Commander Hancock orders.

Lieutenant Houghton grips two of the handles more firmly. One pull and 550 pounds will be dropped by each.

"Elevators amidships, Allenly," Lansdowne orders.

"Tail's a little down, sir," the mast advises.

"Take your time," Lansdowne replies. "I don't want to get off heavy."

Everybody knows that the clamps, which fit like bent fingers into the rim of the cone, have been released, and that the big ship, gently balancing her length on the still air, will float free from the mast like a feather.

"Five seconds on 110," Lansdowne orders.

Houghton switches handles and pulls. Five seconds spill 300 pounds of water ballast. In the keel 2,200-pound rubber bags hang on each side of frames 40, 100, 110, and 170. Each of them drops 30 pounds a second when a handle in the control car is pulled. Four emergency bags are at frames 30 and 180 and two at 194, each of which drops 550 pounds of water ballast in one splash.

Only 300 pounds lighter, but she starts to rise.

"Free, captain!" comes a shout from the mast.

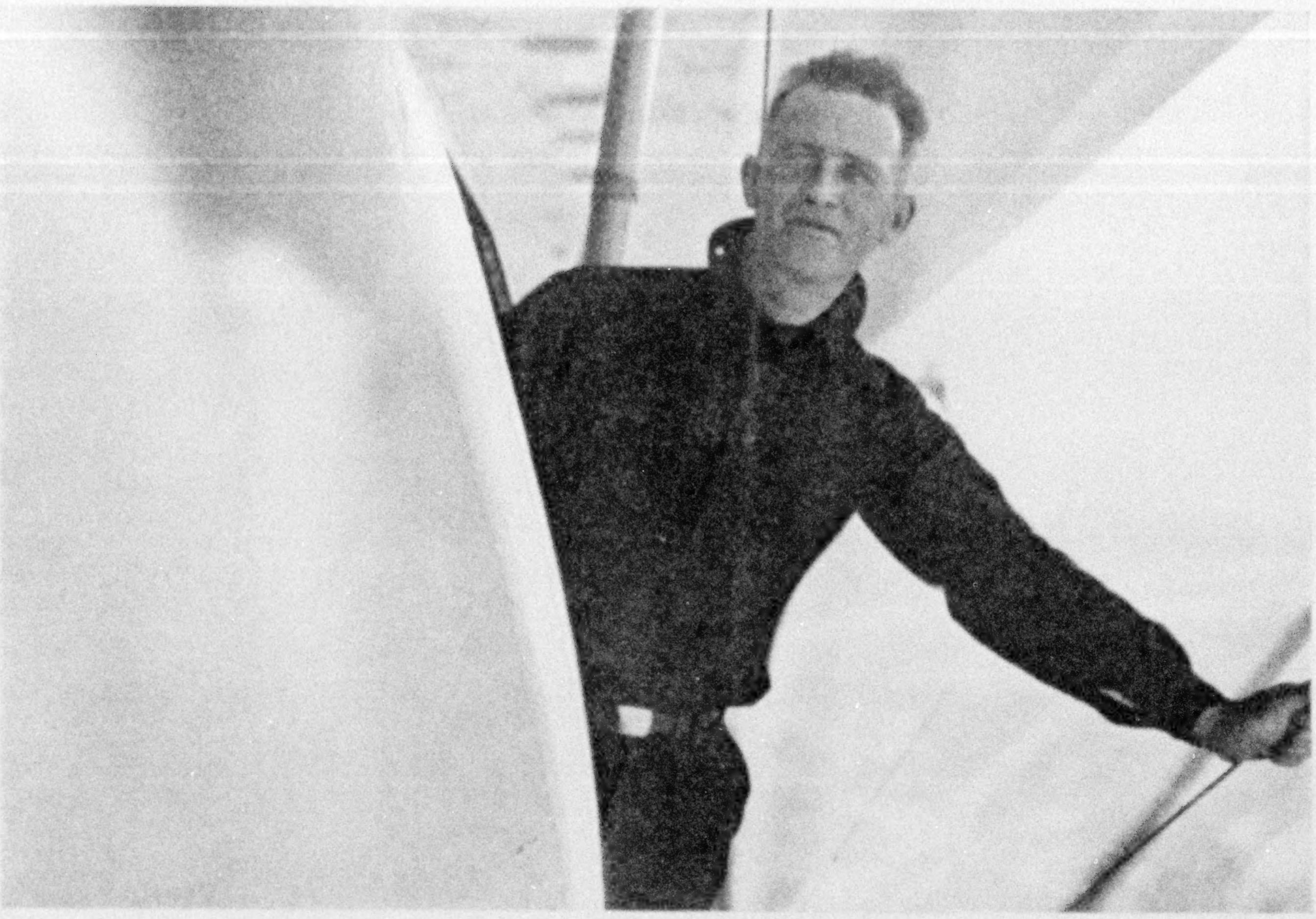
THE SHIP STARTS TO SETTLE

The ship sways just a little more. Slowly she starts to settle, as she falls away from the supporting mast.

"Water forward!" Lansdowne exclaims, sliding from the window to his feet.

Her nose stops, poised and almost imperceptibly starts upward. Aft she is still dropping.

"Water aft!" he exclaims. Houghton is pulling handles and water is pouring on the ground. She teeters like a swing board.



Photograph by Junius B. Wood

LOOKING DOWN 6,000 FEET INTO IMPERIAL VALLEY

The radio is stilled a moment, while Radio Gunner George W. Almour, who, with Lieutenant Carlton D. Palmer, maintained communications, leans outside the door of the radio "shack." The *Shenandoah* established radio communications on the short waves with some 200 amateur stations in 39 States. It communicated also with 14 Navy, 6 Army, and 6 commercial stations, and sent and received 45,332 words during the 258 hours it was in the air (see text, page 30).

"Water again, forward, quickly!" Lansdowne says, almost excited.

"Standard speed," he adds. Her nose has drifted back from the mast. The drive ahead can be risked.

"Standard speed, sir," Sheppard echoes. The levers click, bells jangle and repeat, as the levers fly back again. Quicker than it can be told, the men, hands on the throttles in five separate cars, like one machine, have their motors roaring at 1,200 revolutions a minute.

Slowly the ship gathers headway. She seems to hesitate, as if reluctant to leave, holding her nose toward the ground.

"Pull the water in her nose," Lansdowne snaps.

"Pulled, sir," Houghton echoes, as 550 pounds more drop in a single splash, spraying the windows of the forward car.

The nose bobs upward from the released ballast. It is equivalent to dropping three men. One man walking the length of the ship when the engines are not running changes her level 3 degrees, so carefully is she balanced. After she is under way they can move at will, the elevators by their resistance to the air keeping her trim. However, men cannot be dropped overboard to lighten the ship. Men, engines, and a certain amount of fuel and oil are not classed as "disposable" ballast.

"Two more men aft," he adds in the same breath.

"How far, sir?" asks Lieutenant Mayer, as he runs up the ladder.

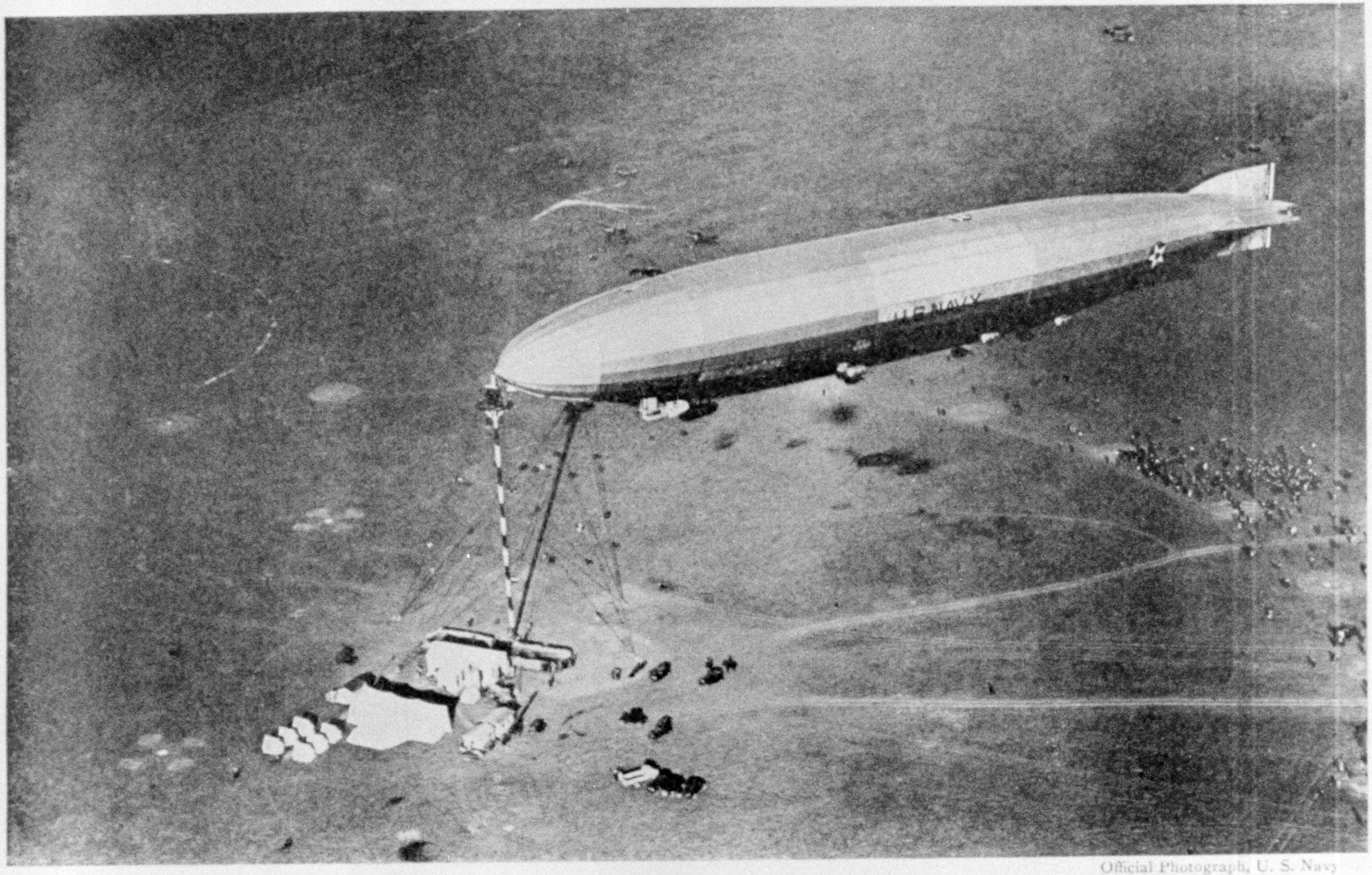
"All the way."

"A man from 105 and a man from 60, into the tail," is shouted down the long keel tunnel. The vibration of the motors drowns the thud of their feet, as they race uphill along the narrow runway.

The ship is rapidly gathering headway. Her nose is pointing upward at an angle of 10 degrees.

"She's all right," Commander Hancock vouchsafes.

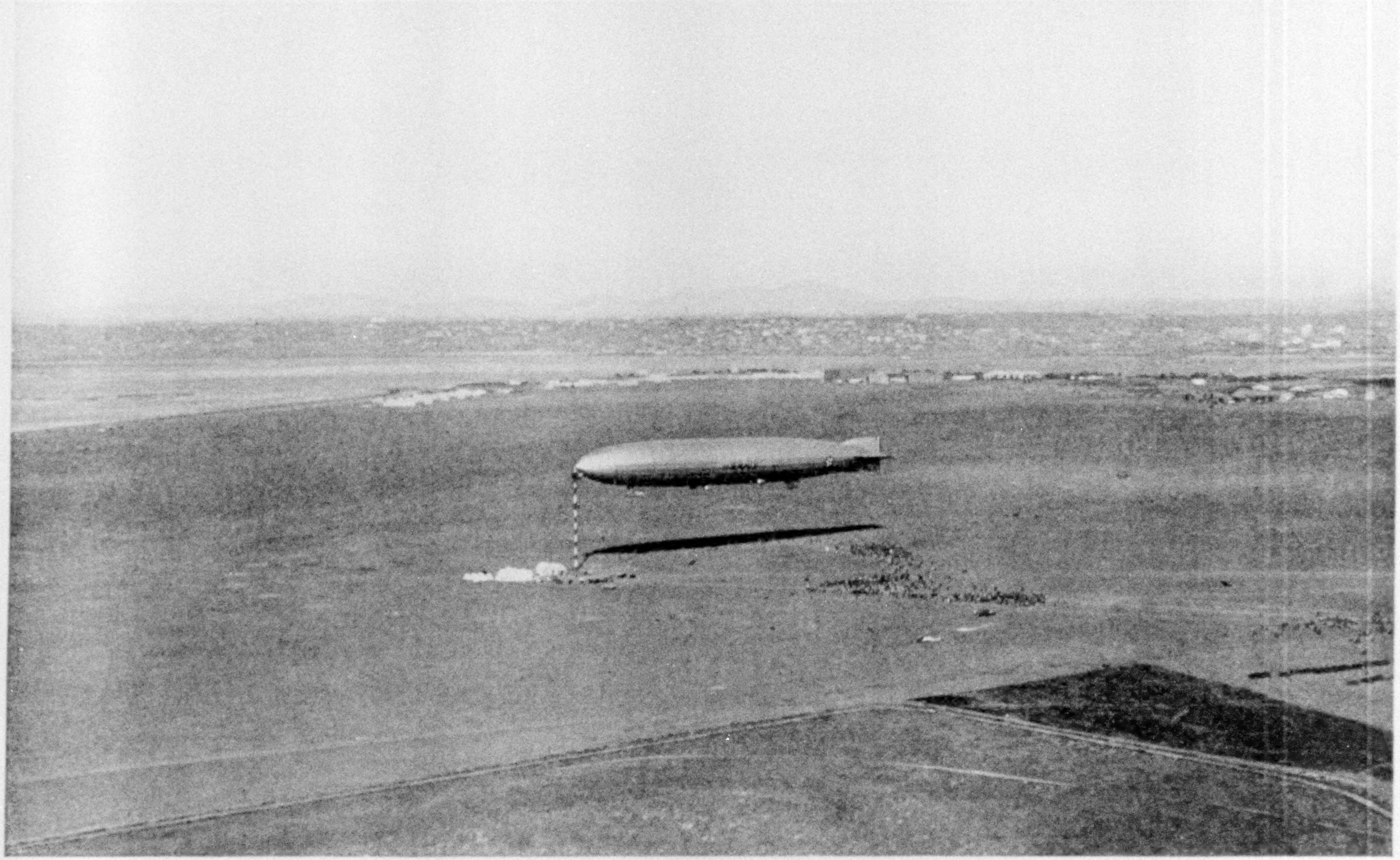
"Watch your rudders," cautions Lieutenant Rosendahl, with an eye on the



Official Photograph, U. S. Navy

RESTING AT SAN DIEGO BEFORE BEGINNING THE FLIGHT NORTH

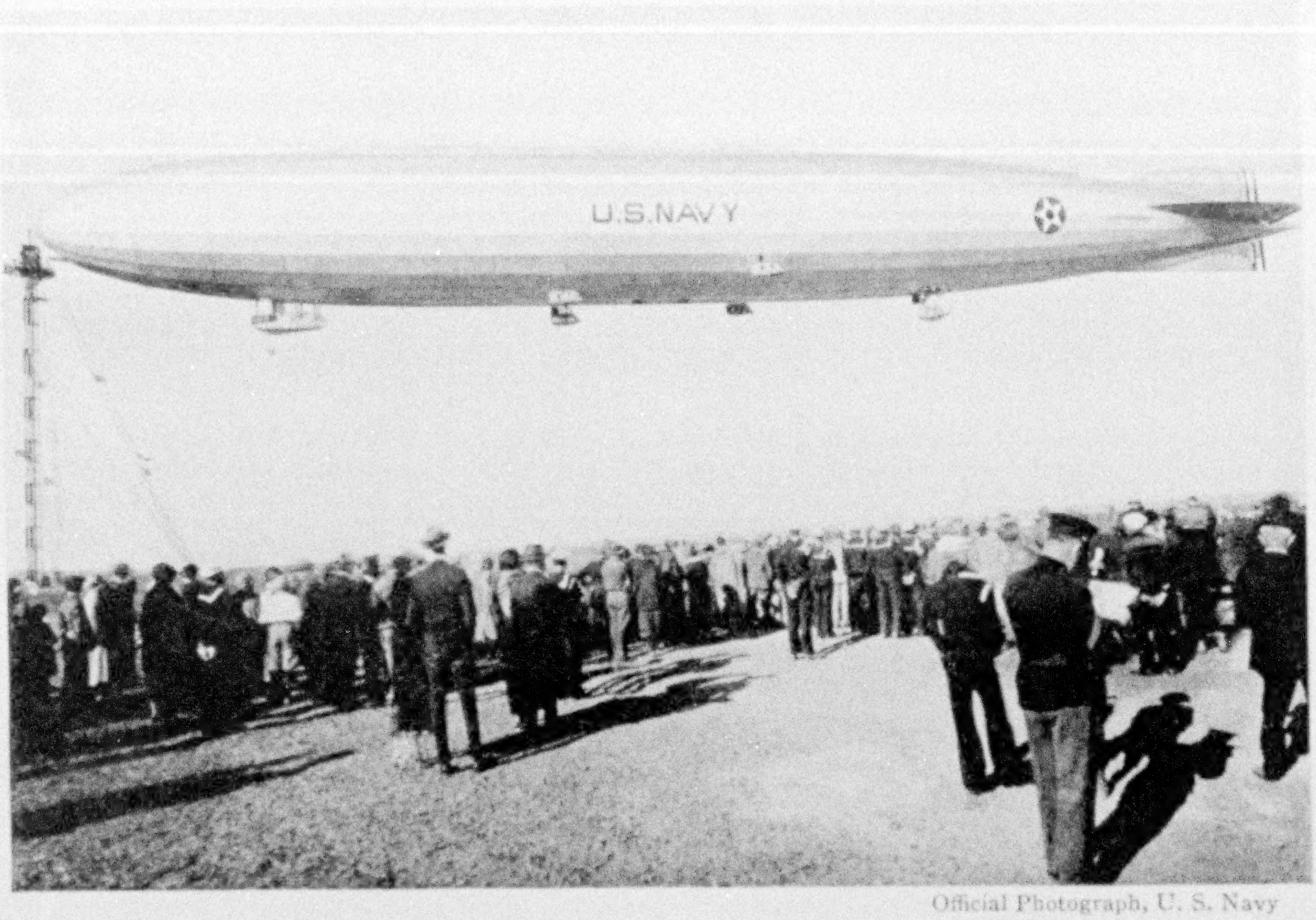
From end to end the airship is equal to nearly three average city blocks and at its widest portion there is sufficient space to house a five-story building with a frontage of 50 feet and a depth of 100 feet. Its length is two-thirds that of the *Leviathan*, yet its weight is only 41 tons, compared to the *Leviathan's* 50,000 tons.



Official Photograph, U. S. Navy

THE FIRST RIGID AIRSHIP TO VISIT OUR PACIFIC COAST

The ship reached the North Island naval air station at 10:48 p. m., October 10, but was not moored until 1 a. m. The only accident of the cruise occurred during this landing, in which the rear gondola struck the ground. The jolt buckled one of the girders in the triangular runway (see diagram, page 8). The girder was replaced while the ship was at the mast, and though five days were necessary for the work, it proved that major repairs could be made at a mooring mast (see text, page 37).



Official Photograph, U. S. Navy

SAN DIEGO RESIDENTS GETTING THEIR FIRST VIEW OF A RIGID AIRSHIP

Before beginning the fabrication of the *Shenandoah's* frame, it was necessary to produce a new metallic substance, duralumin, an alloy of aluminum and copper, with the strength of steel and the lightness of aluminum. If the tips of a girder of duralumin 16 feet long and so light that it could be balanced upon one's little finger, are placed on blocks, it will bear the load of eight men sitting upon it.

mast which he has just left and which the ship's tail seems to be clearing by inches.

"Stand by to cut out fuel tanks," Lansdowne orders, and Bauch scampers up the ladder, pulling the cutting pliers from his pocket.

Even fuel must go if necessary. The speeding motors can increase the ship's lift 10 per cent, but that means tipping her nose upward by means of the elevators. After an angle of 13 degrees is reached, the maximum lift is obtained and the only relief is to drop ballast.

CASTING OFF TAKES 16 MINUTES

The casting off, including the interruptions from clouds and delayed fuel, had taken only 16 minutes. The waiting until the sun generated sufficient heat was of several hours.

"Climb as fast as you can," Lansdowne orders.

"She's climbing, sir," responds Allenly at the wheel.

Patches of mist lie over the bay. The city seems too near for comfort. Automobiles and persons around the mast are becoming specks.

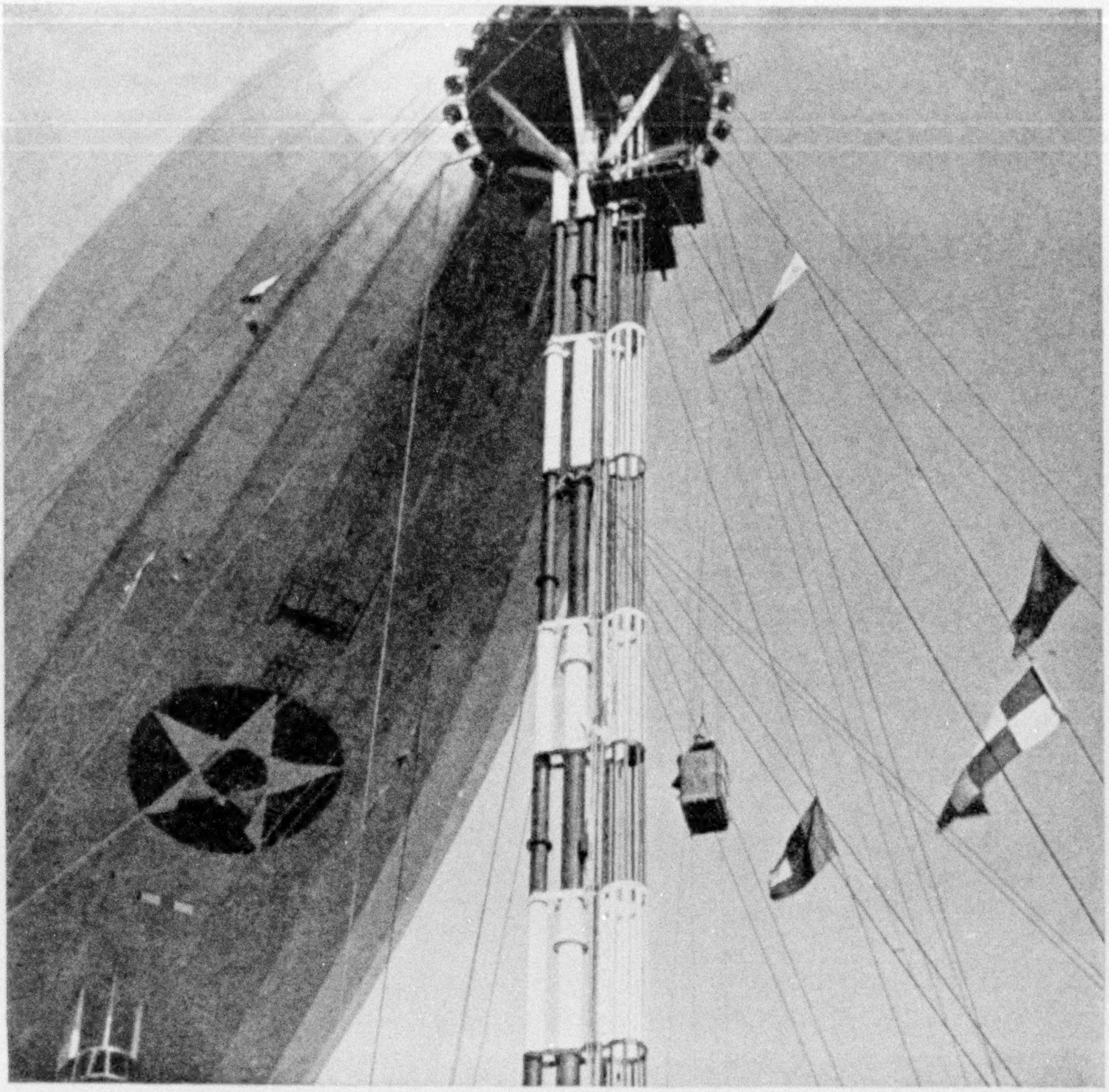
"She's 500 feet above the mast, sir," says Hancock, as we circle upward.

"Keep her climbing," Lansdowne repeats.

"How high, sir?" Houghton asks.

"As high as she'll go, Regg," the skipper replies, as the tension relaxes. "Take her to pressure height."

Pressure height usually is 4,500 feet—that is, if the ship starts with her bags 85 per cent full of helium. As she ascends into more rarefied atmosphere the gas expands, keel officers and riggers pulling and straightening the bags, until at 4,500 feet they are full. Through the keel, in the apex of the triangular tunnel, runs a big rubber pipe, connected with each of the 20 bags. When the twine which closes their mouths is unwrapped, the gas circulates from one to another until the pressure in each is equal.



Official Photograph, U. S. Navy

THE BASKET ELEVATOR ASCENDING THE SAN DIEGO MOORING MAST

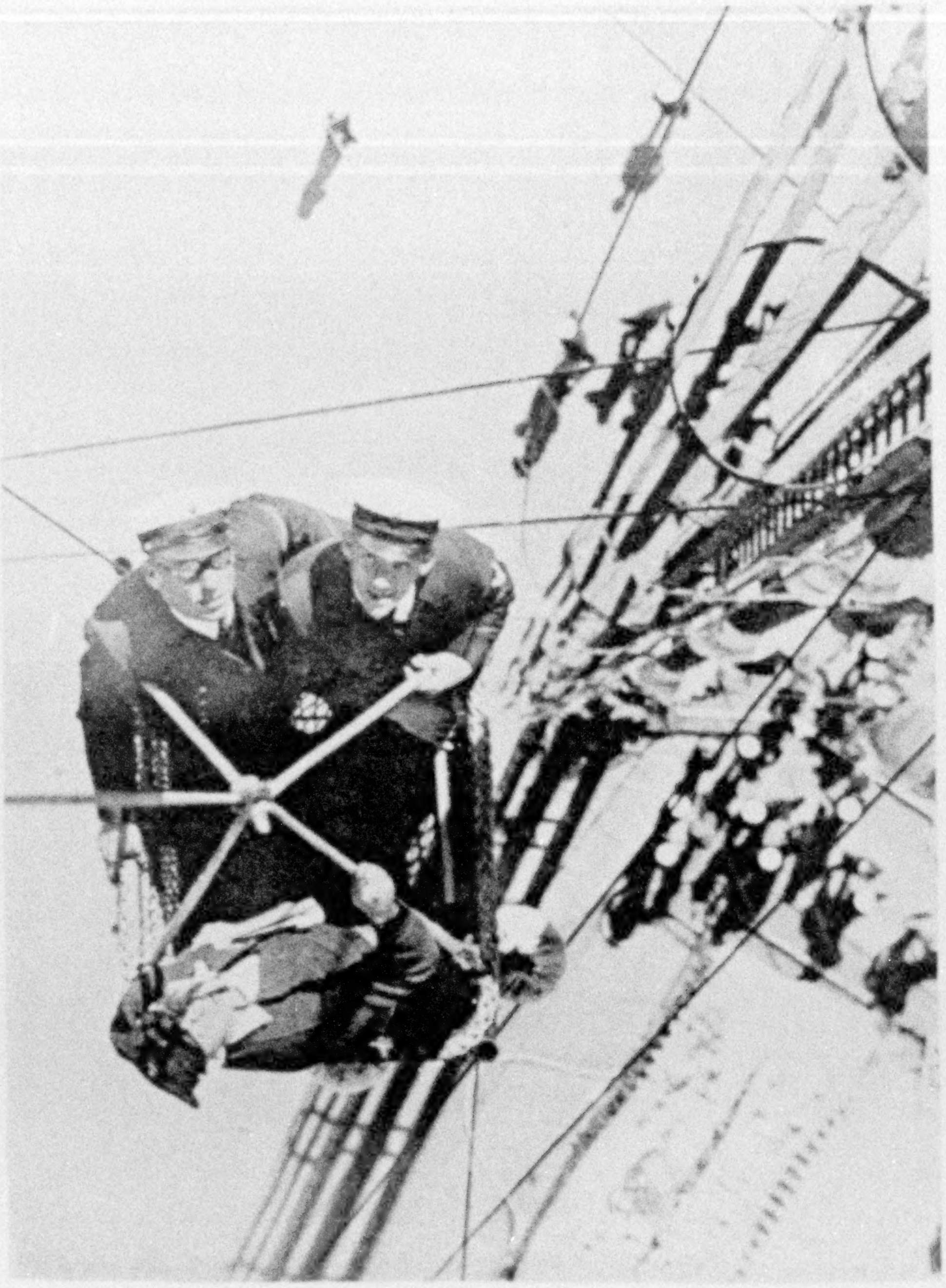
While the nose rests on the mooring mast, extreme care must be used in boarding the ship in order not to disturb the delicate balance (see text, page 1). Naval authorities admit that, with all its remarkable accomplishments, the *Shenandoah* is an experimental airship, and that new developments and refinements will produce superior craft.

At 4,500 feet, bags and pipe are swollen almost to bursting. Higher than that, the straining gas escapes through safety valves and the ship's lifting capacity diminishes. The load must be reduced a proportionate amount.

Casting off and mooring are much the same operations, only reversed. In each the ship is headed into the wind; it is balanced along its length, so as to be parallel with the ground, and put out of equilibrium, so as to be light or heavy, according to whether the ship is leaving or landing. In casting off, ballast is dropped to make the ship lighter. In landing, gas is valved to make the craft heavier. The engines are of no assistance in lifting until after the ship is free from the mast, or in landing after its downward drive has stopped.

HELIUM IS TOO EXPENSIVE TO RELEASE FREQUENTLY

As the noncombustible helium gas which the Navy uses costs $55 or more per 1,000 cubic feet, valving is frowned on. With the dangerous, but inexpensive, hydrogen, landing can be made almost at will. Similar liberal valving of helium would cost from $5,000 to $20,000



Photograph by International

GOING ABOARD AT THE NORTH ISLAND AIR STATION: SAN DIEGO

Three of the officers are being hoisted to the top of the 173-foot mooring mast (see also illustrations, pages 17 and 19) to board the ship for its northern cruise along the Pacific coast. Storms and head winds caused this trip to be prolonged for more than 57 hours, including the time consumed at Tacoma to avoid the valving of helium.

for each landing. Consequently, advantage is taken of Nature's changes. Landings are made at night, when the ship is cool and heavy, and departures well after sunrise, when the gas is superheated and light.

The gas is extremely sensitive to temperature. Frequently, even as late as midnight, when the ship drops within 300 feet of the ground and the engines cannot be used to drive it farther, it bounces up again like a rubber ball, from the heat still in the earth.

Temperature of the ground, in addition to wind velocity and direction, is always ascertained before attempting a landing.

To make a landing, a crew of 200 or 300 men is needed to hold the ship down. To make a mooring at a mast, a dozen men on the ground are sufficient to couple the two cables and start the machinery. To lead a ship out of a hangar requires the same ground crew of several hundred. To cast off from a mast, the only assistance required from outside is to uncouple the gas, fuel, and water pipes and snap back the clamp holding the ship's nose.

The engines help to drive the ship down until it is within a certain distance of the ground. If it is going directly to the mast, a steel cable is dropped, which the men below couple to one from the top of the mast; the ship rises again and a dummy engine pulls its nose down to the mast.

If the ship is going to land on the ground, ropes are dropped, and the ground crew swarms on them like flies as soon as they are within reach. A trained crew is required.

In the fraction of a second that the ship is stationary—the infinitesimal pause between the time engines are driving it down at 45 miles an hour and the buoyant gas starts to shoot it up again—dozens of men must grab the rope and hang on. A second too early would knock them over, as if catching an express train, and an instant too late would skyrocket them heavenward.

An enthusiastic Filipino messboy jumped and grabbed a rope once and rose 30 feet before he could let go. He awoke in the station hospital.

The record of Chief Petty Officer O'Shea is famous in Navy annals. O'Shea held one rope of a basketless free balloon and some 40 men held the other.

"Let go!" shouted the captain to O'Shea.

"Let go!" echoed the 40 gobs. They did. Like a flash, O'Shea was 100 feet above the ground, at the end of a 40-foot rope. Before it occurred to him to let go, he was several hundred feet higher, and it then was too late. O'Shea started following the rope hand over hand. The balloon was shooting up like a rocket, and if O'Shea's "think tank" was slow, it was determined and unflustered. The last his comrades saw of him before he was a disappearing speck, he had almost reached the bull ring under the bag.

A near-by observatory reported that he was a chilly 14,000 feet high when he gave up trying to reach the flapping valve rope and started to rip the side of the balloon.

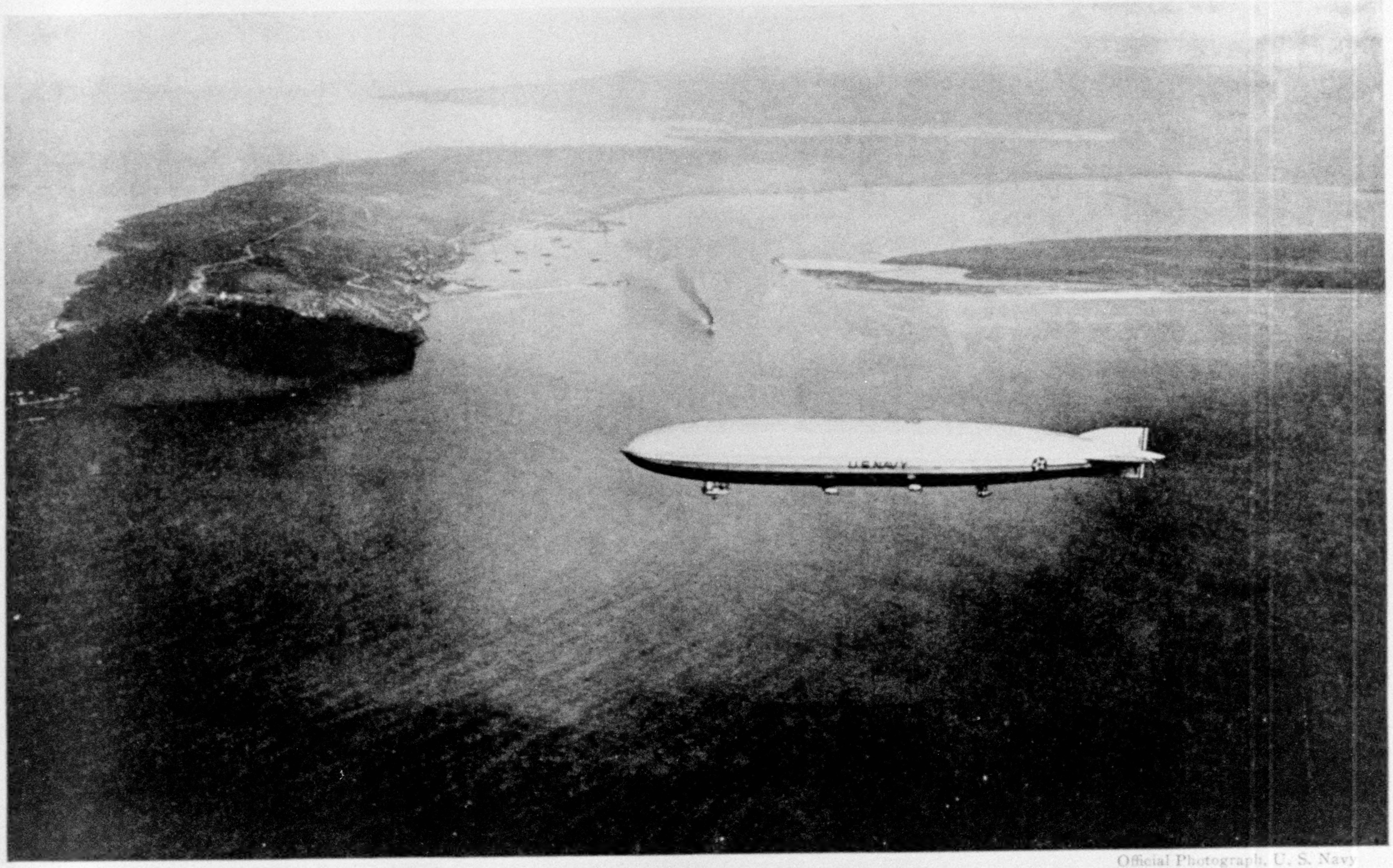
Photograph by International

A CLOSE-UP OF THE "SHENANDOAH" HITCHED TO HER MOORING MAST

The swivel pear on the ship's nose fits into a cup on the tower. In mooring, a cable is dropped from the ship to the ground and is hooked to another trailing from the mast. A winch pulls the ship down until its nose meets the clamp. The gangplank door (see illustration, page 4) is here shown closed. The *Shenandoah's* "wild night" during the storm of January 16-17, 1924, in which the ship broke from its mooring, is regarded by aviation authorities as one of the best possible tests of ship and mast that could have occurred.

It started down in wild circles, O'Shea now on top and again on the bottom. The flapping bag caught in the net, parachuting a few hundred feet, then rolling into a ball and dropping like lead for a thousand, unfolding again into a glide, until finally O'Shea landed, fortunately, in a river. He could not swim, but was fished out, asked for a cigarette, and made no comments.

Later, O'Shea became so excited over an argument with his wife that he piloted a balloon over the family home and dropped the sand ballast, without bothering to take it from the bags, with such accuracy that a hit was made through the kitchen roof at the busiest hour of wash day. O'Shea was retired from the service, but his experience is part of



Official Photograph, U. S. Navy

OVER THE PACIFIC OFF POINT LOMA

"The weather was raw and hazy, with head winds down the coast, when the *Shenandoah* cast off from San Diego mast. . . . Fifteen minutes later she had rounded Point Loma and was headed northward, over the Pacific Ocean, and 5 miles offshore" (see text, page 39). Captain Stanford E. Moses, commander of the air squadron of the battle fleet; Lieutenant Commander R. D. Kirkpatrick, battle fleet aviation officer, and Joe Johnson, moving-picture operator, joined the ship for the cruise to Tacoma.

lighter-than-air curriculum, as illustrating the danger of grasping airship guy ropes without holding the motion open for immediate reconsideration.

FLYING OVER NEW JERSEY, PENNSYLVANIA, AND DELAWARE

As the *Shenandoah* left her home mooring mast at Lakehurst, 10 a. m., October 7, she described a broad circle with a 5-mile radius, until the altimeter on her "bridge" showed 1,300 feet. That was the level above the sea, and in New Jersey it meant practically the same above the ground. A few days later, when the same altimeter registered 7,300 feet, going through the Rocky Mountains, she was only a few hundred feet above the bottom of the canyon and the menacing peaks on either side were above her.

Jersey, with its little lakes and big hotels, patches of fertile farms and smoky cities, miles of stunted pine and cranberry bogs, was left behind when the Delaware River, opposite Chester, Pennsylvania, was reached at 11:25. The *Shenandoah* followed the river, her shadow trailing below like a big fish on its surface, until Wilmington, Delaware, was passed, 20 minutes later. Baltimore was below at 1:37 p. m.

Going 55 miles an hour, the start and finish of a race at Laurel were seen from a safe altitude of 3,000 feet. An escort of airplanes came out from Washington, the ship passed between the Monument and the White House at 2:10, and the District of Columbia was crossed in 10 minutes (see page 9).

THE EARTH SEEMED COVERED WITH RUGS AND CARPETS

As she sailed along over the low, rolling hills of Virginia, straight into a fire-red sun whose last rays were tinting the tops of the forests in gay autumn hues of red and yellow, the first purple haze of evening had fallen on the streaked brown fields and green pastures in the valleys.

From the skies the undulating earth seemed covered with carpets in drab and green and rugs of bright colors, cut into squares and strange shapes and marked with strings of white, which were highways.

Darkness fell below while the sun still was striking through the windows of the navigating gondola. The ship was over Orange, Virginia, at 3:59 p. m., Charlottesville at 4:35, Esmont at 5, Norwood at 5:30, and Lynchburg at 6:20. Danville, Virginia, was below at 8:10, and a few minutes later the *Shenandoah* was sailing over North Carolina.

Under the moonlight, the tree-covered earth, with an occasional light which twinkled and disappeared, lay black and mysterious below. Several aboard had drifted over that country in balloons and had memories of rifles which spat from below and bullets which punctured gas bags. One balloon had returned to its station with 17 holes. Possibly residents in those lonesome hills were suspicious of spies from the sky, looking for moonshine stills which were inaccessible to revenue agents below.

In the silent night the hum of the *Shenandoah,* as she passed high in the air, could be heard for miles, but no hostile bullets greeted her.

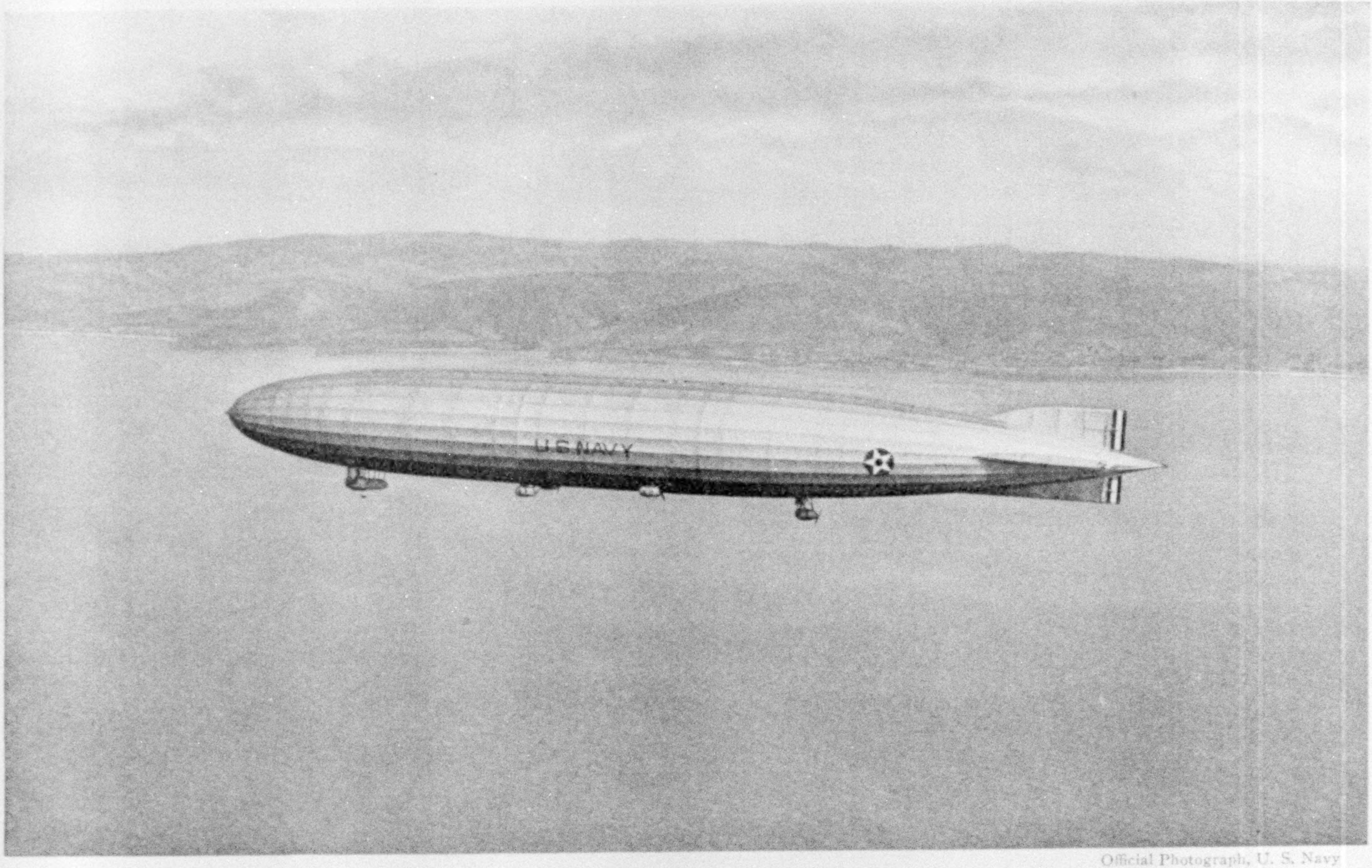
FEW LIGHTS GLOW ON THE SHIP AT NIGHT

Greensboro was an electric cluster in a black setting at 9:20 p. m., High Point was 1,000 feet below at 9:55, a dozen colored flares burning in a greeting which was easily understood, and Salisbury followed an hour later with a salvo of locomotive whistles from Spencer into town, dimly echoing to the ship. Gastonia, North Carolina, was a fading glow at 12:37 a. m., October 8, and at 1:27 Gaffney, South Carolina, was directly below.

In the navigating gondola the electric light over the chart table was flashed on only to glance at a map or make an entry in the log. A faint glow came from the little bulbs behind the spirit levels and compass.

White running lights were on the forward and aft gondolas, green lights on the two starboard cars, and red on the two on the port side. Within, all was dark, except for a moment on the bridge or for the glow from electric torches in the long tunnel in the keel, as men passed back and forth, changing watch in the engine cars, measuring fuel tanks, inspecting motors and gas bags, and performing other tasks which required constant vigilance.

The ship is not wired for lights. Only those in the navigating room, in the radio



Official Photograph, U. S. Navy

OFF NEWPORT BEACH SOUTH OF SAN PEDRO, CALIFORNIA

shack, and the running lights are on batteries. Each individual carries his own torch. Though helium gas will not burn, no fire is permitted aboard. The only sparks are in the six motors—one runs the radio generator—and in the little two-burner gasoline cookstove in the latter's closet.

In the dark the long keel is eerie with phosphorescent figures and letters, which glow from every latticed frame or piece of emergency gear, with lights which flash in the distance and disappear and lights which suddenly appear from nowhere, while one fur-padded form leans at a danger angle and another passes on the ribbon of a runway.

Day and night the life of the airship is in the keel. It is a triangular tunnel running the length of the ship. Its base is the thin cotton bottom panel of the outer covering of the big tube; its equilateral sides are the gas bags, when they strain full against the wire and twine network which holds them in place.

"THE CAT'S WALK"

In the center, 682 feet long from nose to tail fins, is the runway, 9 inches wide. It is called "the cat's walk," from the skill required to tread it. The thin cotton covering, 12 inches below, gives a false sense of security; but the ground, usually 3,000 feet below, is only two steps removed. A roughly stitched rent in the cotton shows where one man made the first step, and with true sailor veracity the marks of his fingers are shown where he gripped the steel-hard duralumin to save himself from taking the second step.

No admonitions are needed to walk the straight and narrow path. The crew, as nimble as structural steel workers, trot along, pass each other, and even stop to wrestle.

Four lateral runways pierce the sides of the tube to ladders leading into motor gondolas. Though the runway is precarious, negotiating an uninclosed ladder 3,000 feet above the ground while speeding 70 miles an hour requires cooler nerves.

Men skip up and down and even stand on the gondolas to watch the passing scenery. One night in the mountains the chief on his hourly inspections found a door closed at the bottom of one of the ladders. Considerable kicking made him heard above the din of the motor. He inquired why everything was closed.

"You see, we were so close to the mountains, and I saw some goats and was afraid one might jump in here," the man explained.

HOW THE GAS AND WATER BAGS ARE DISTRIBUTED

Every 5 meters in the tunnel, corresponding to the outer circular ribs, is a triangular frame of latticed girders. In the center of the ship the triangular frames are 12 feet across and 9 feet between base and apex. The sides become shorter in the ends, and heads are bumped and cut by the cross-girders. One bump convinces the most skeptical of the rigidity of the *Shenandoah*.

In the upper angle of the triangle is the rubber gas pipe, wilted and loose or puffed to the size of an 18-inch water main, according to altitude. Flanking it are the metal fuel and water pipes. At the sides, distributed so the load will be equalized through the length, are the 724-pound gasoline tanks, the smaller cans of lubricating oil, and the sleeping bunks for officers and men. One habituated youth slept in a hammock, only the cotton between him and space, as comfortable as if his bed were swung between the towering aërials of the Arlington wireless station.

At intervals along the runway are three decks, little 12-foot-square platforms of thin plywood. One is for the mooring equipment and the other two are euphoniously designated as officers' quarters and crew's quarters. Though discipline does not deteriorate, "side" is lacking on an airship. Instead of a suite of three rooms and private bath and messboy, to which a rear admiral is entitled on a battleship, his private bunk is not different from those of the crew. The same-sized shaving mirrors, the only luxury aboard, hang in both quarters. The rations are the same, the combination cook and messboy is the same, mess hours are whenever anybody has time to eat, and as the food, including the hot soup, is distributed from the crew's quarters, the officers frequently munch their dry sandwiches there.

Official Photograph, U. S. Navy

THE AIRSHIP'S AIRPLANE ESCORT OVER SAN DIEGO

San Diego is the headquarters of the Eleventh Naval District. The southern route from New Jersey to Texas was chosen because it eliminated the necessity of crossing the Rockies at the great heights farther north. The mountain passes required skillful management of the ship; in fact, the navigation of a rigid airship through the atmospheric ocean entails the same expert execution as navigation at sea.

In daytime the keel is fairly light, through the white cotton flooring, which is not blackened inside, as is the remainder of the outer tube.

At night it is dark and mysterious. The emergency dials glow like ghostly faces with cabalistic words and signs, dots and dashes for levers and buttons. The chill wind whistles against the thin covering, and the motors, which never stop, roar right beneath. Silent muffled figures are huddled on the bunks, some wormed into padded sleeping bags, others bundled in fur suits, fur mittens, and wool boots. Lights always are flashing and moving in the dim distance.

HALF THE SHIP SLEEPS WHILE OTHER HALF WORKS

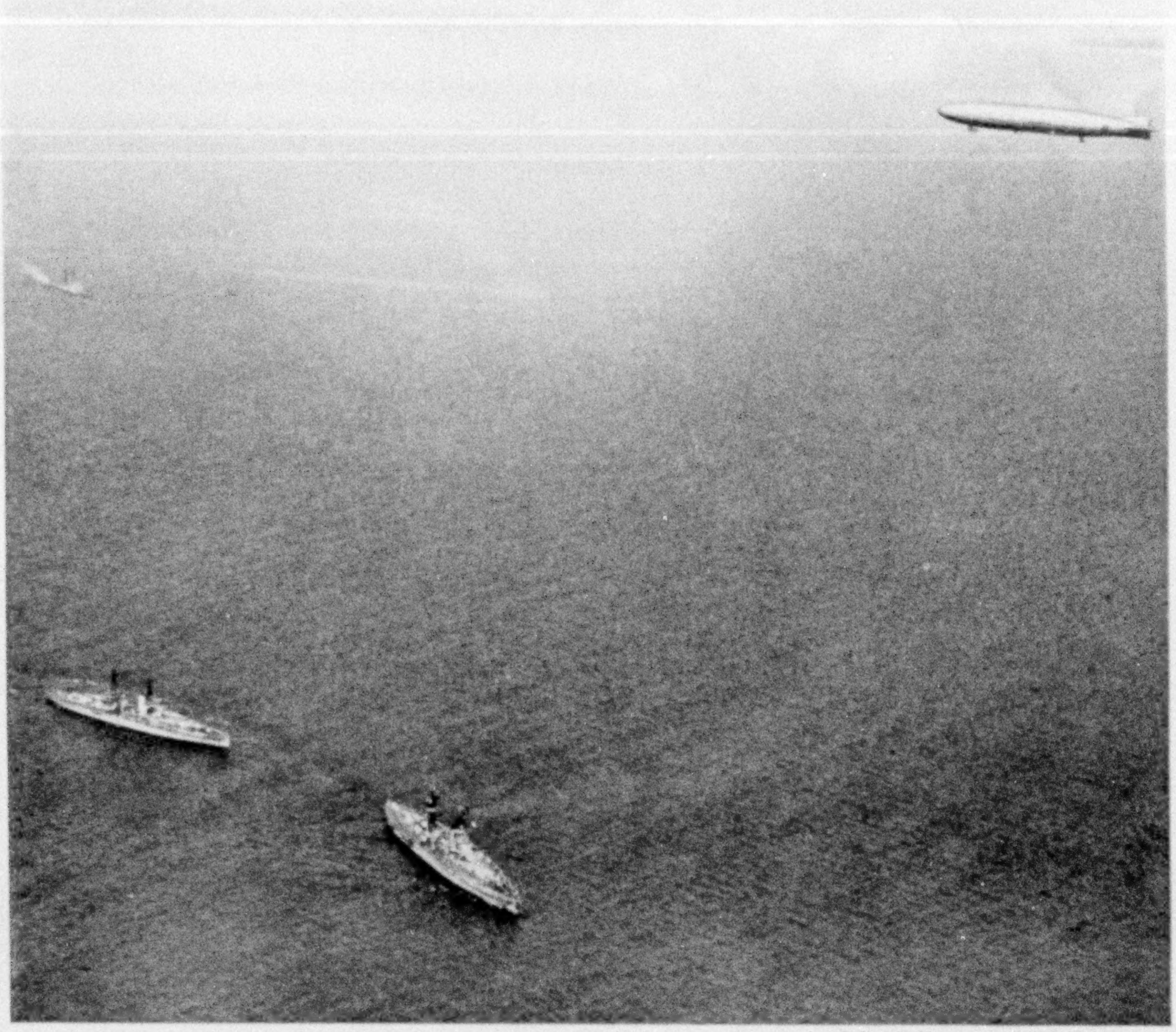
On the crew's deck, lit by a dying electric bulb, will be a group of men who have come off duty—wheelsmen with weary eyes and arms, machinists with ears stuffed with cotton, drinking hot coffee from tiny paper cups—and a chief figuring out his hourly report of the fuel consumed and the gallons of converted water ballast.

While half the ship sleeps, the other half watches and works, day and night, four hours on and four hours off. Other nights were like the first night. The routine never changed any more than did the mad roar of the motors.

Scenery differed with every hour, winds rose and fell, the moon faded from a fat white ball to an emaciated crescent, some nights were foggy and others were clear, but life never varied in that long tunnel, like an uncanny shaft of a mine floating thousands of feet in the air.

Spartanburg, South Carolina, was crossed at 1:57 a. m.

The morning sun was following up over the hilltops, cutting long furrows through the mist hanging in the valleys, before Atlanta was reached. Atlanta was rubbing the sleep out of its eyes at 4:35 a. m. (central time), but, judging by the number on the streets, a large share of



Official Photograph, U. S. Navy

SALUTING THE BATTLE FLEET OFF SOUTHERN CALIFORNIA

"The battle fleet was at target practice, shots ricocheting across the surface, with splashes a mile apart, in San Pedro Channel, off Catalina Island."

the population had left a call, possibly with the fire department, to be awakened when the *Shenandoah* was heard approaching. Carrollton, Georgia, was left behind at 6:32 and the Alabama border crossed a few minutes later.

Long before Birmingham was reached, at 7:15 a. m., the mantle of smoke from her steel mills was visible. Railroads and devious highways wound through the valleys and hills, gullied by freshets of many years, over which the ship was speeding at 55 miles an hour. Three Army airplanes came out to meet her.

Birmingham's whistles could be faintly heard, 2,500 feet below, and nearly every roof on the cluster of skyscrapers in the center of the city was crowded with spectators, their faces white dots in the distance.

From Birmingham to the Black Warrior River the forest seemed without a break.

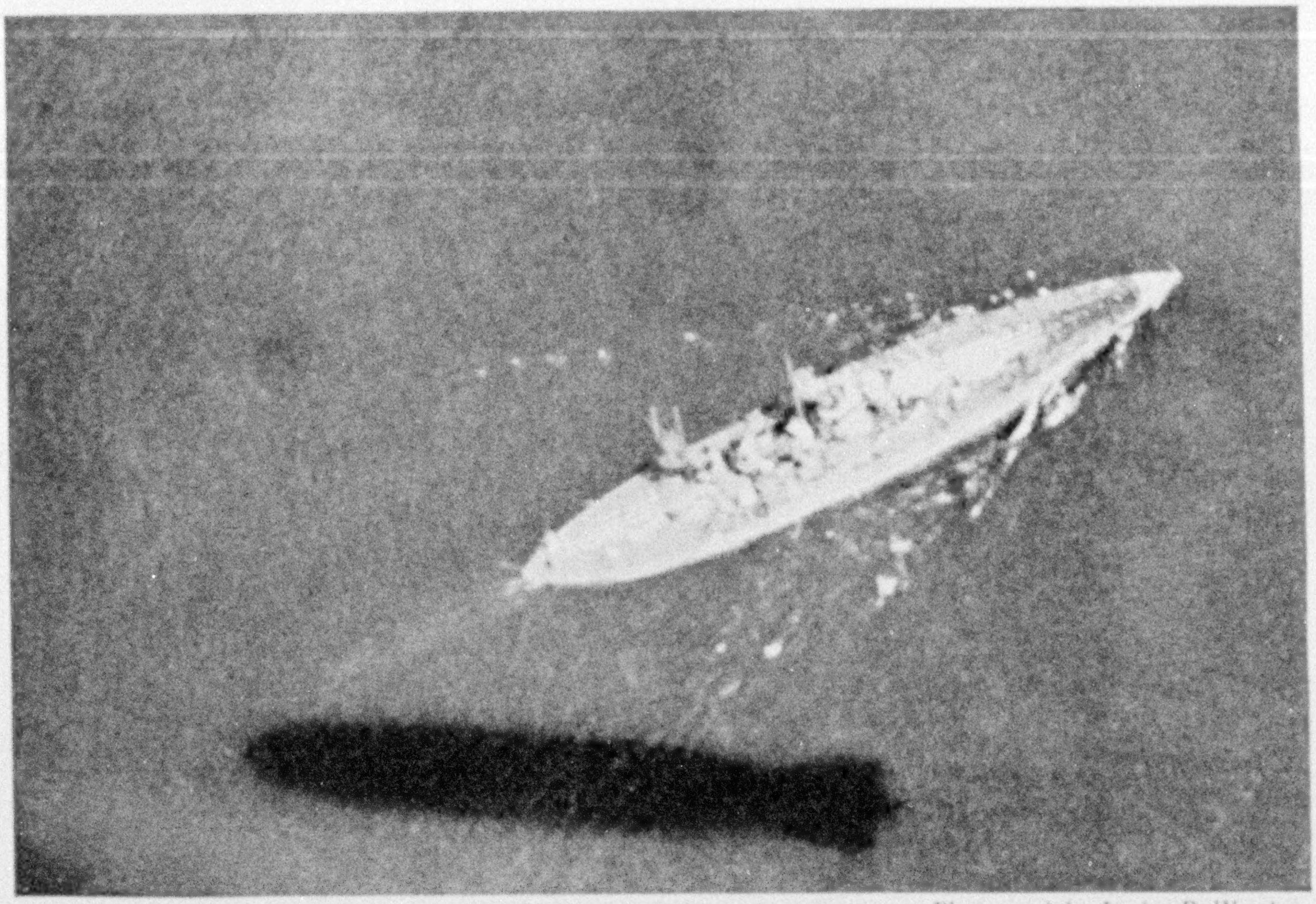
Motors were running at only two-thirds speed, 1,000 revolutions a minute, but the ship was making time, with a fair wind behind.

OVER THE LAND OF COTTON

The Mississippi border was crossed and Columbus was below at 9 a. m. Greenville and the Mississippi River were crossed at 11:47.

Many of the 24 States sailed over had a Columbus and a Greenville on the route. Columbus may have been an omen for a pathfinding ship and one Greenville was the birthplace of Commander Lansdowne.

Through the second day the *Shenandoah* was over the land of cotton. Bas-



Photograph by Junius B. Wood

THE AIRSHIP'S SHADOW PASSES THE U. S. S. "CALIFORNIA"

The flagship of the navy of the air passes the flagship of the battle fleet off San Pedro, California. Greetings were exchanged between Admiral S. S. Robison, commanding the fleet, and Rear Admiral Moffett.

kets of white and scattered groups of darker figures were in the fields, and square bales, dice in the distance, were piled at every railroad station. Clearings around weather-beaten houses with dirt roads faintly visible through the trees would spring out of the forests. Every house seemed to have a family with numerous children. While chickens and cows ran in terrified circles, the children would gaze in awe or wildly wave greetings.

One portly colored citizen—the glasses disclosed him to be such—dashed into the house and reappeared waving a white tablecloth to make sure that he would be noticed.

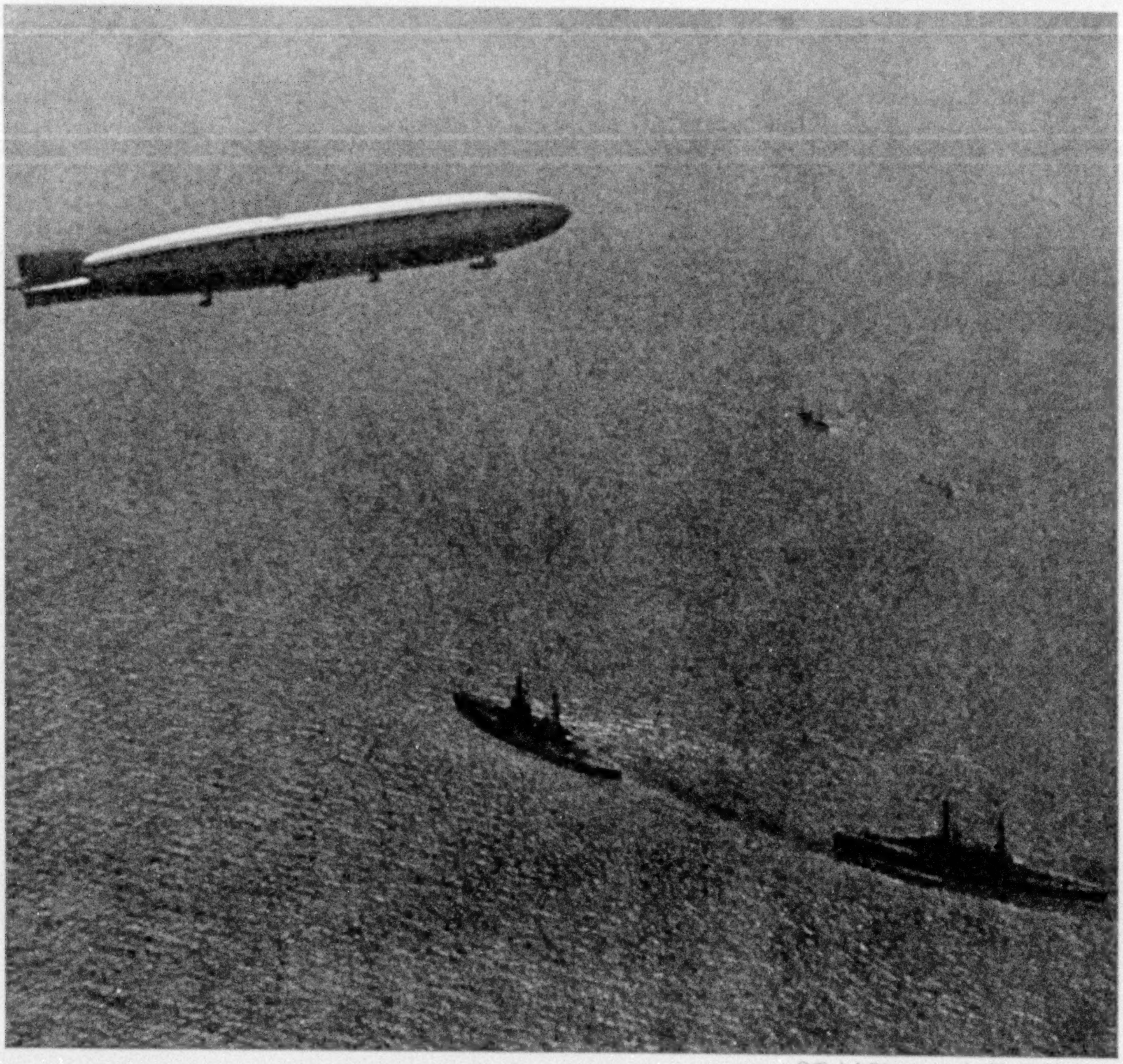
Fires were smoldering through the forests of Louisiana. Columns of smoke rose lazily as high as the ship, and the dull glow of burning brush could be seen through the trees, waiting only a wind to fan the blaze to their tops. It was the same in Arkansas through a night on the return voyage, two weeks later.

The *Shenandoah* was over Bastrop, La., at 2:10 p. m., passed Shreveport and the Red River at 4:15, and was almost to Texas. Night had fallen when the lights of Dallas twinkled below at 7:40 p. m. At 8:30 p. m. she was above the mooring mast, 8 miles outside of Fort Worth. At 9:45 she had cooled sufficiently to approach low enough to drop her cable. The cables were coupled and she rose to be pulled down to the mast.

As frequently happens with new machinery, the winch balked and it was 11:05 p. m. before she was wound down by hand and anchored.

Fort Worth is the home of helium gas, of which the United States claims a monopoly. It is extracted from natural gas, and the Navy's helium plant, in charge of Lieutenant Z. W. Wicks, is about a mile from the mast. Other gas deposits contain helium, but none so far discovered has sufficient quantity to be extracted economically (see also pages 97-99).

Fort Worth was enthusiastic, as was all Texas. So many thousands of the



Official Photograph, U. S. Navy

SAYING GOOD-BY TO THE BATTLE FLEET OFF SAN PEDRO

The silver covering of the big tube is stretched over a skeleton of girders, and comprises 16,000 square yards of heavy cotton cloth. It is painted black inside to mellow the rays of the sun. On the outside, a coat of waterproof aluminum paint shrinks it tight on the frame.

well-known make of automobile which will run in all seasons over Texas plains were entangled in the surrounding fields and roads that many of the shirt-sleeved, sombrero-crowned drivers did not get their families home before daylight.

Fort Worth had a reception committee keyed up for a week of hospitality. It was crestfallen when told that the *Shenandoah* would remain only over night. It was the same on the return voyage.

The president of a West Texas boosters' club, a hearty man whose black hair matched his black frock coat and broad-brimmed black felt hat, had crossed the big State to be present on that occasion. He was only one of several thousand. He preached the gospel of irrigation for the vast open spaces of his end of the State, also for mariners of the air, but his generous offer was declined.

FORT WORTH IS LEFT BEHIND

At 9:46 a. m., October 9, the *Shenandoah* left the mast, circled over Fort Worth, followed the main boulevard, over the schoolhouses with their yards filled with children, over the six-story mansion where Dr. Cook has been allotted a 14 years' residence, and was off toward Tolar.

The difficult leg of the voyage—to cross the Rockies—was starting.

Officers and crew had worked through

Official Photograph, U. S. Navy

FLYING OVER THE RESIDENTIAL SECTION OF WEST LOS ANGELES

This airship comprises many wonder stories of modern science. Direct contributions to its development include new types of radio equipment, new developments in engine design and performance, new operative methods in driving propellers, and new machine-shop methods. Its long cruise tested the practicability of the American innovations added to the plans laid down by Zeppelin.

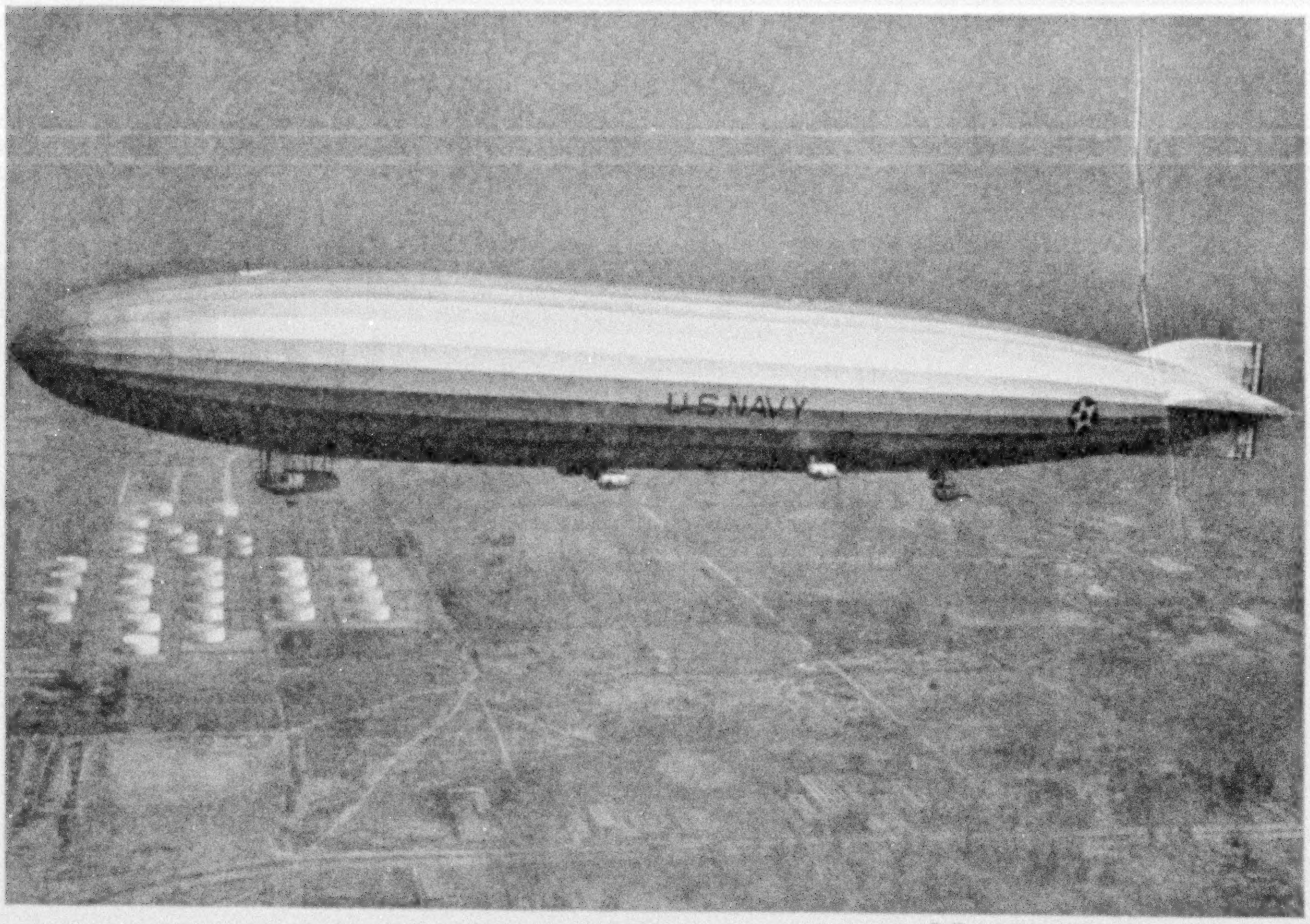
the night and 17,016 pounds of fuel, 850 pounds of oil, and 2,500 pounds of water had been taken aboard. Her gas cells bellied inward, only partially full, along the inside tunnel. As she climbed over the mountains they would be taut, 5,000 cubic feet of gas escaping through the safety valves for every 100 feet of altitude above the pressure height.

Ranger slipped by at 12:45 p. m., Eastland and its oil spindles at 1, Cisco at 1:12, and Putnam at 1:30. In the clear atmosphere which continued through that day and the next to the California border, the horizon was 50 or 75 miles away, and the ship, almost a mile above the surface, could be seen for miles. However, ranchers, accustomed to gazing across the plains, would dash for the nearest windmill and climb its ladder, believing that they could see the ship better.

Another unfailing manifestation in cities was to discover a speck in the center of a street start into sudden motion, disappear under the little square which marked a home, immediately to reappear with a cluster of specks representing the family.

GETTING THE RADIO MESSAGES TO THE AMERICAN PRESS

It seems that all the automobiles in Putnam were on a hill outside the town. Two miles farther the glasses disclosed a dozen cars around a derrick operated by a farm tractor, the drivers watching a freshly struck oil gusher. Five minutes later a railroad train was overtaken in the midst of the plains. It had stopped and crew and passengers were on the ground gazing skyward. School children of Baird, at 1:45, their bright-colored



Official Photograph, U. S. Navy

THE PRIDE OF THE NAVY OVER OIL TANKS IN THE VICINITY OF LOS ANGELES

dresses like blowing flower petals, ran along the street after the ship.

Whistles, which echoed faintly 3,000 feet above, announced Abilene at 2:20 p. m. The population was on the roofs or in the center of the streets. In the railroad pens, sheep and longhorns milled around in fright.

The radio operator aboard had been talking with an amateur in town. He stopped suddenly, explaining when he resumed that he was "out looking at the ship."

This was only one of some 200 amateur operators with whom the ship established communication during the cruise. Thousands of others heard the radio either broadcasting talks from the ship or handling messages by Morse code.

Most of the amateurs were members of the American Radio Relay League, and it will be a revelation to many to know that hundreds of these amateurs are communicating across the country day and night, exchanging serious and frivolous messages, but establishing a great, unseen system of communication which might be a national resource in emergency.

These operators stood by through the cruise, ready to send or receive messages. There was seldom an hour, day or night, that one or more could not be raised. Many were boys, one was a bedridden youth, others were retired telegraph operators, and a few were former Navy operators.

Messages they received were turned over to the telegraph companies or relayed by their own system across the country.

Occasionally they were in towns almost under the ship, but usually they were several miles away. Many were in small villages or in lonesome parts of the country.

Until its call was answered each time, the *Shenandoah* did not know where it was picking up an operator.

One night in Oregon, near midnight, an amateur answered from Dayton, which the Census Bureau credits with a population of 448. "Is the telegraph office open?" he was asked. "No, but there's one 10 miles from here and I'll get it there," he answered. He took the message. The next day, when that item on the *Shenandoah's* cruise had been car-

Official Photograph, U. S. Navy

PASSING OVER CLOVER FIELD, SANTA MONICA, CALIFORNIA, EN ROUTE TO SEATTLE

Both the *Shenandoah* and the *Los Angeles* (formerly the *ZR-3*) are expected to prove mighty factors in scientific investigation for determining the practicability of rigid airships in peace. Note the escorting planes surrounding the big ship.

ried by press associations to all the newspapers of the United States, few who read realized the romance of the message from the air and none knew the many links, not the least of which was that free-hearted 20-mile ride through the chilly night which had started it over the country before dawn.

One lad excitedly "broke" the message which he was receiving to explain "Everybody in town's outside the door and the telegraph manager's here to get it." Another urged haste, as he had "a date with a peach" in an hour.

TRYING TO DISTINGUISH BISBEE FROM DOUGLAS, ARIZONA

In addition to the amateurs, the *Shenandoah* was in communication with fourteen Navy, six Army, and six commercial stations. Not counting messages exchanged by telephone or talks which were broadcast, 45,332 words were sent and received during the 258 hours the

Photograph by Junius B. Wood

THE FERTILE FIELDS OF CARPINTERIA, CALIFORNIA, AS SEEN FROM THE AIR

The surf edges with white the Spanish "Carpenter Shop," named in August, 1769, by Friar Juan de Crespí and his companion pioneers, who found the Indians making dugouts here. The town's famous old grapevine, eight feet in circumference, and the largest in the world, died in 1916, but is preserved for exhibition purposes. The lima bean in California was first raised commercially in the Carpinteria Valley. English walnut and lemon groves thrive in this vicinity.

Shenandoah was in the air. Most of them were weather reports and press messages, the former received and the latter sent.

When the officers are not too busy, talks on the *Shenandoah* and the trip were broadcast at night. These were not announced in advance. Hundreds who picked them up by accident wrote describing their amazement when a voice from the speeding ship sounded over their parlor speaker. Several were in isolated ranch houses or mountain lodges. On account of the clearness of the voice, many inquired whether the messages came from the *Shenandoah* in the air or from a big land station.

The enthusiastic fire chief of Chehalis, Washington, wrote: "It was so foggy when you past over that we couldn't see you, but we rung the fire bell and blowed the sireno, and I ran into the house and put on the earpieces and listened to you talking."

When it was uncertain whether the ship was over Bisbee or Douglas, Arizona, the resourceful Lieutenant Palmer asked his auditors, being sure that he had some, to tell the automobilists in the streets to flash their lights on and off—slow in Bisbee and fast in Douglas. He opened the door of the gondola and leaned out. Headlights already were starting to flash below—fast, slow, and assorted speeds. It was Bisbee, as was later ascertained, but no two persons in Bisbee agreed on what was slow.

THE RADIO EQUIPMENT

The new records which the *Shenandoah* made in radio science were, to a large extent, due to the human factor. Lieutenant Carlton D. Palmer and Radio Gunner George W. Almour, the two operators, are among the most experienced and efficient radio experts in the Navy. One was on duty constantly and several times daily both were operating simultaneously.

Official Photograph, U. S. Navy

SKIRTING THE MOUNTAINS OF THE PACIFIC COAST

This coast is, in general, rugged, the high land in many places rising abruptly from the sea. The same storms which the *Shenandoah* rode through over the Pacific sent ships on the rocks and others to dry docks for repairs.

The radio "shack" is a separate gondola, but so close to the forward navigating gondola that from the outside it appears to be the tail end of that car. The little radio room is reached by a narrow door from the navigating compartment. It was so small that two operators facing their keys and array of tuning dials cannot sit back to back.

The two antennæ hang under the car within a few feet of each other. In a closet between the two compartments is a special-type gasoline engine driving a 60-ampere direct-current generator which charges a 24-volt storage battery. The generator ran 24 hours a day, except once when it was taken down and reassembled in flight.

This closet was also the ship's galley, where the coffee, soup, and beans were heated on two gasoline burners. It was so much smaller than the radio room that two men could not stoop at the same time, let alone sit down.

The main transmitter was a 6-tube Navy aircraft standard type SE-1390, modified to permit the use of telephone. It operated on a continuous frequency range of from 600 to 250 kilocycles. An antenna, 450 feet of copper cable weighted with a 15-pound lead "fish," was dropped for this set.

Photograph by Junius B. Wood

THE BIG SHIP'S SHADOW OVER SUMMERLAND, CALIFORNIA

Once a pleasure resort, Summerland invaded the ocean bed in 1891 and pumped oil out of it. The field was soon completely drilled, however, and only a few wells still remain in operation.

When this set was used for broadcasting, the antenna was reeled in to 216 feet and three tubes were removed, giving a 150-watt output, four-ampere radiation, and 525-meter wave-length. The auxiliary transmitter was the latest type from the Navy's research laboratory at Bellevue, D. C. It used both continuous wave and telephone on 3,332 kilocycles. In addition were four "receivers"—long, intermediate, and short wave and compass, each of seven tubes except the short wave with three.

Actual performances of the auxiliary transmitter and the generator were far greater than the most sanguine had anticipated. It demonstrated the reliability of a lightweight set on aircraft under all conditions. Transmission in the air was four times as far as is possible from the ground. The ship was in communication with the Bellevue laboratory every night, the mountains never interfering, and by chance with the U. S. S. *Canopus,* in the Pacific near the Equator, and with a commercial station in Norway. Before starting, this transmitter was expected to work 500 miles only at night.

THE GEOGRAPHY OF THE TEXAS PLAINS VIEWED FROM THE AIR

The vast open spaces of Texas were breaking into hills half an hour after Abilene was left, at 45 miles an hour. Part of Sweetwater had trekked out of town and the remainder was on roofs and freight cars at 3:14 p. m. Two women and a little girl in bright sunbonnets had climbed a barren hill.

Roscoe, with its little squares of cotton, was below at 3:28, Colorado at 3:55, and Iatan at 4:20.

A train which had been attempting to keep pace gave up the race at the little town consisting of a railroad station, water tank, three houses, and a cattle corral. The first of the foothills of the Rockies had been reached, and the road would curve and climb while the ship sailed straight ahead.

Railroads and highways are straight for a hundred miles in the corrugated-

Photograph by Junius B. Wood

OVER NAVARRO HEAD, CALIFORNIA

This cliff, 405 feet high, lies on the north bank of Navarro River, north of Point Arena, California. "Dogs, whales, and pelicans seemed the only denizens of earth, water, or air which were not terrified by the ship. Dogs barked, while other live stock ran; a pelican followed the ship's shadow on the surface, as if it were a possible fish, while the whales played with it for miles" (see text, page 40).

tin-roof and red-paint belt of Texas and in New Mexico and Arizona as well. From the little cow stations, automobile tracks stretch just as straight across the plains, disappearing in the distance, but showing that life is beyond. Even the cattle paths do not curve as they radiate from the water holes which spot the drab, dry country without regularity or reason.

Big Spring, with the First National Bank roof as an observation tower and the town whistle blowing off steam, dropped back at 4:46. Near Stanton the radio gondola felt a twitch, but the 60-ton ship did not pause. The "fish" at the end of 450 feet of antenna had taken a dive into the dry soil of Texas and stopped. So did the radio. The Navy lost a $50 fish, which was not as serious as the escapade of a "fish" from a flying boat, which entangled itself in the skirts of a buxom spectator, and a solemn Navy board is still endeavoring to adjudicate the damages to fish and calf.

Though the *Shenandoah* was climbing, the ground was coming up faster.

Midland, with the Llano Hotel as a roof garden, was below at 6:47, Odessa 30 minutes later, and at 7:50 the Pecos, both river and town, were crossed at an altitude of 4,500 feet. At 9:50 she was over Van Horn, with an altitude of 6,600 feet, and still climbing. Ears sung from the rarefied air.

EVERY MAN ON DUTY AS THE SHIP SPED TOWARD THE MOUNTAIN PASS

The ship was lighter, from the fuel which had been consumed in the 12 hours from Fort Worth, and the gas was cooled both by the chill night and by the 74-miles-an-hour speed; but the bags were swollen and straining against the nets, and gas flowed in a steady stream through the safety valves into the wicker chimneys to the ventilators above.

Water ballast had been dropped until only fuel could be jettisoned to lighten her further.

Photograph by International

THE "STORM DAUGHTER" AGAINST SAN FRANCISCO'S SKYLINE

The ship's nose is over Golden Gate Park. In the central foreground of the picture is the Museum, with Stow Lake to the left center and the Stadium beyond. In the right background, Cliff House may be faintly distinguished. Sea lions disport on the rocks below, and Point Lobos, on which the building stands, received its name from the Spanish *lobos marinos*, or "sea wolves."

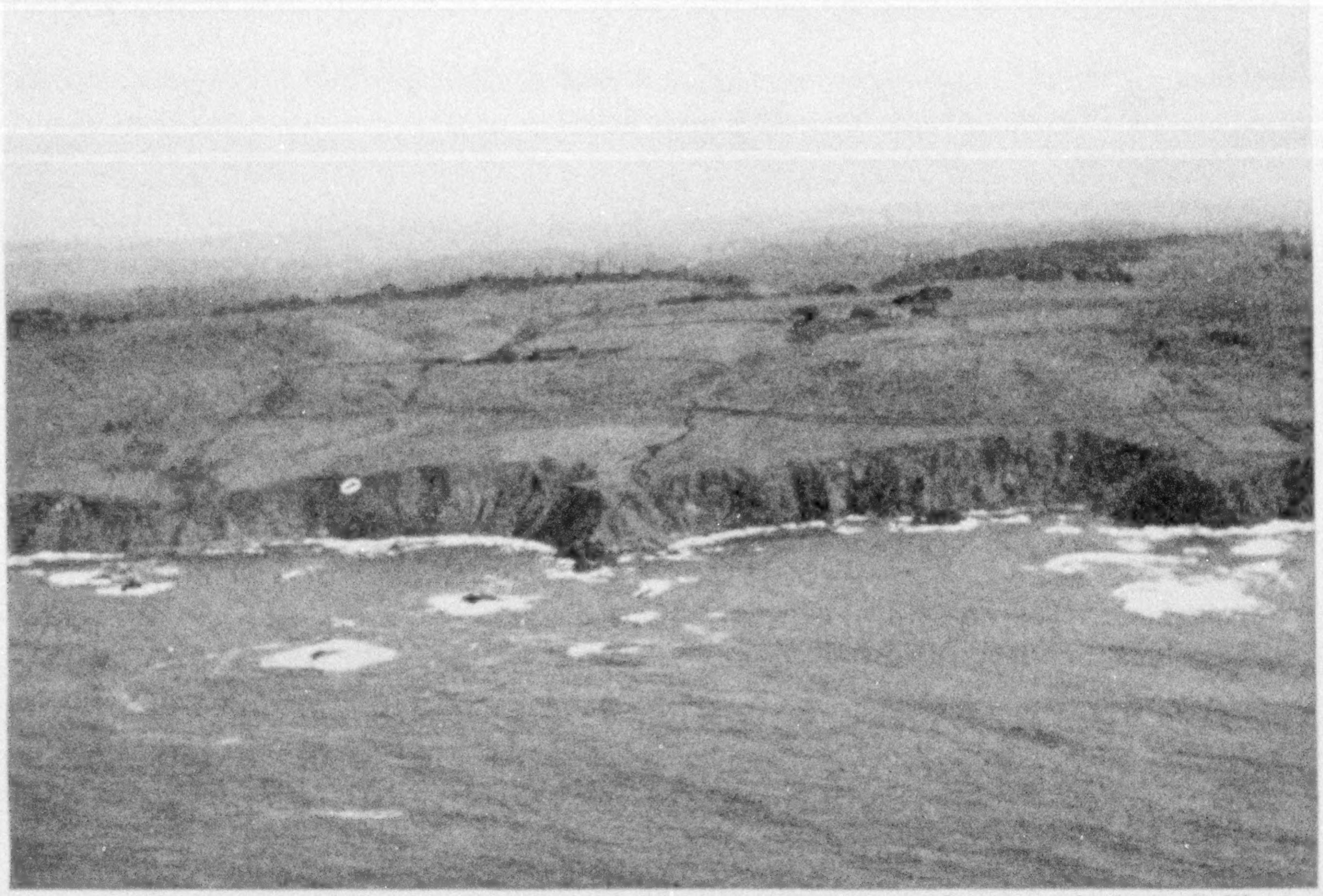
The *Shenandoah* was rushing toward the first of the mountain passes, with cross-winds whipping around the peaks and eddying into the valleys below. Every man was on duty.

Half of the officers were in the navigating car. Others patrolled the keel, watching the gas cells or ready to cut out more ballast.

Two men were on duty in each of the motor gondolas. Time was figured in split seconds; each man was ready, so close might be the difference between safety and destruction. Commander Lansdowne was on the "bridge."

The ship was now going through the passes, keeping as low as possible to save gas, but an unforeseen emergency might force her to rise suddenly and go over the ridge.

The clear night with a full moon was almost as bright as day. In the bottom of the valley thin lines of black and white under the moonlight were the railroad and highway on either side. Open fire boxes of passing locomotives sent up a red glow and automobile headlights made long flashes on the road. Red and green pin points of switch lights and the white clusters of tank stations came and



Photograph by Junius B. Wood

OFF MENDOCINO, CALIFORNIA

"To the person who has lived a lifetime with his feet never more than a few inches from the ground, . . . the mere idea of soaring through the air seems the great feat. To the aviator, the working of his motors is the ever-present consideration" (see text, page 6). Casting off and making landings are the critical operations of airship navigation; sailing is comparatively simple.

vanished, as the ship followed its winding course.

The black peaks were above the ship and the brown, furrowed shoulders of the mountains seemed to reach out in the pale light to rub the fragile side of the graceful intruder. They came close, but always fell back.

The eddying wind blew in fierce gusts, which if they had swerved the 682-foot tube, would have dashed it to pieces in the narrow pass.

The lights of Sierra Blanca were below at 10:15 p. m., and the giant ship was speeding through the tortuous channel at 60 miles an hour. Her motors were roaring at full speed, 1,400 revolutions a minute. She responded to her rudders without a quiver, riding as smoothly as a ship on a calm sea.

The line of white road disappeared through the mountains and the black ribbon of steel vanished into a tunnel. The *Shenandoah* climbed and passed over the top. Ahead could be seen the valley of the Rio Grande. The first ridge of the Rockies had been crossed. Fort Hancock, on the river, was below at 10:45, and the course was headed northwest, toward El Paso, skirting the loops of the winding stream and Mexico, lying darkly beyond.

TEXAS IS LEFT BEHIND

El Paso gave a welcome of whistles, flashing flares, and a searchlight, which played on the sides of the ship when she sailed over, at 11:30 p. m., and left Texas behind. Strong winds followed up the valley. She sped across New Mexico at 79 miles an hour, over Deming at 12:10 a. m., October 10, and Lordsburg at 1:32.

When the Arizona line was crossed, at 2:10, the winds changed. The *Shenandoah* fought them until she reached her hangar at Lakehurst, two weeks later.

Bowie, Arizona, was below at 3:07 a. m. The ship's nose was pointed toward the canyon beyond; Dos Cabezos, 7,300 feet high, guarding it on the south, and

the Pinaleno Range, more than 10,000 feet high, on the north.

A 25-miles-an-hour wind was whistling out of the mountain pass. The moon had slipped behind a cloud, and the dim line of railroad which we had been following was no longer visible. The headlight of a locomotive flashed into view far ahead in the pass and the *Shenandoah* drove toward it into the wind. The current caught her broadside. She drifted for a breathless second. The rudders held and she slowly slid forward between the towering peaks, which rose out of the gloom, and into another valley.

"THE WORST OF THE ROCKIES CROSSED"

Cochise was passed at 4:12 a. m., and the even narrower Dragoon Pass was ahead. The lights of the little cattle station of Manzoro were below at 4:30, and the *Shenandoah* was driving into the pass. In the dim starlight it seemed that the mountain walls were within a few feet on either side, and that the long ship could not turn in the narrow defile. A freight train showed the way into the inky tunnel and the ship worked slowly through. Benson, near the summit of the divide, sparkled ahead at 5:19, the east was faintly pink, and the worst of the Rockies had been crossed. Commander Lansdowne climbed the ladder and threw himself on his bunk.

Tucson, thousands of feet below, looked like gaudy stage scenery with its red roofs, green streets, and white walls on a background of brown desert, under the clear morning sun, at 6:30 a. m. If any inhabitants were awake, they were not visible. No life marred the picture. Maricopa at 8:20, Estrella at 9:40, and Gila Bend, with the Gila River a dark-green line through the clouds of dust far to the north. Irrigated farms were green squares on the prevailing brown. From the air, the new Southwest seems to be growing in squares — towns, blocks, houses; farms, fields, and barns—as life is irrigated into the desert.

A passenger train which had kept pace for a couple of hours slowly pulled ahead and disappeared on the long, straight stretch of track. The *Shenandoah* was alone above the dry waste, disturbed only by an occasional jack rabbit hopping around the sentinel cactus and mesquite.

Mohawk Pass, with a few green-roofed houses and black mountains, straight as a wall, went by at 11:42. Just as little breezes toss the dust into patterns, the winds and waters of years had traced giant figures over this dry country, their lines measured in miles. The broad outlines are disclosed only when viewed from the clouds. From the height at which the *Shenandoah* was sailing, the panorama was unbroken for 50 miles in any direction.

The brown ribbon of the Colorado River, with a fringe of green on its east bank, was crossed at 1:55 p. m. Yuma lay across the river to the south.

Dust dimmed the sunlight, even at the ship's altitude, as it entered California and turned northward along the east shore of the Salton Sea.

The Imperial Valley was another irrigated checkerboard of green, its borders fighting against the shifting sands of the desert as tropical clearings do against an ever-encroaching jungle. Indio was reached at 5:15. Darkness fell suddenly.

Rain and snow were driving against the ship when she reached Banning, at 7:05. Sunny California's greeting, which swept in from the San Jacinto Valley, was frigid. The temperature in the forward car dropped to 35 degrees and the ship started to drop from the chill and weight of snow. This quickly melted, and at 8:10 the course turned westward over San Bernardino, reaching the Pacific off Seal Beach at 9:15.

The *Shenandoah* was over the North Island naval air station mast at San Diego at 10:48 p. m., Pacific time. Thirty minutes later she landed on the field, but was not moored at the mast until 1 a. m.

THE ONLY ACCIDENT OF THE CRUISE

The only accident of the cruise occurred in this landing. The guy ropes were dropped and the ground crew pulled the big ship slowly down. It was the crew's first experience with such a job. Urged by the officers inside the forward gondola, they caught and eased it gently to the ground. The rest of the crew, a city block away, seeing a shape as large as a battleship slowly settling toward them, stood back, and the rear gondola met the ground with a sharp bump. The jolt was transmitted through the struts, which

Photograph by Pacific and Atlantic

THE MOORING MAST AT TACOMA, WITH MT. RAINIER IN THE BACKGROUND

In severe storms, the ship will cast off from its moorings and ride around or rise above the disturbance. Ability to do this would be of utmost importance in meeting the difficulties and dangers of Arctic exploration.

anchor gondola and tube, to the framework inside the latter, buckling one of the vertical girders in the triangular runway.

The ship, when on the ground, rests on the rattan and pneumatic cushions under the forward and rear gondolas. The ship, 682 feet ¾ inch long, is 97 feet 1 inch high from bottom bumper to top. The tube is 78 feet 9 inches in diameter at its eight widest frames.

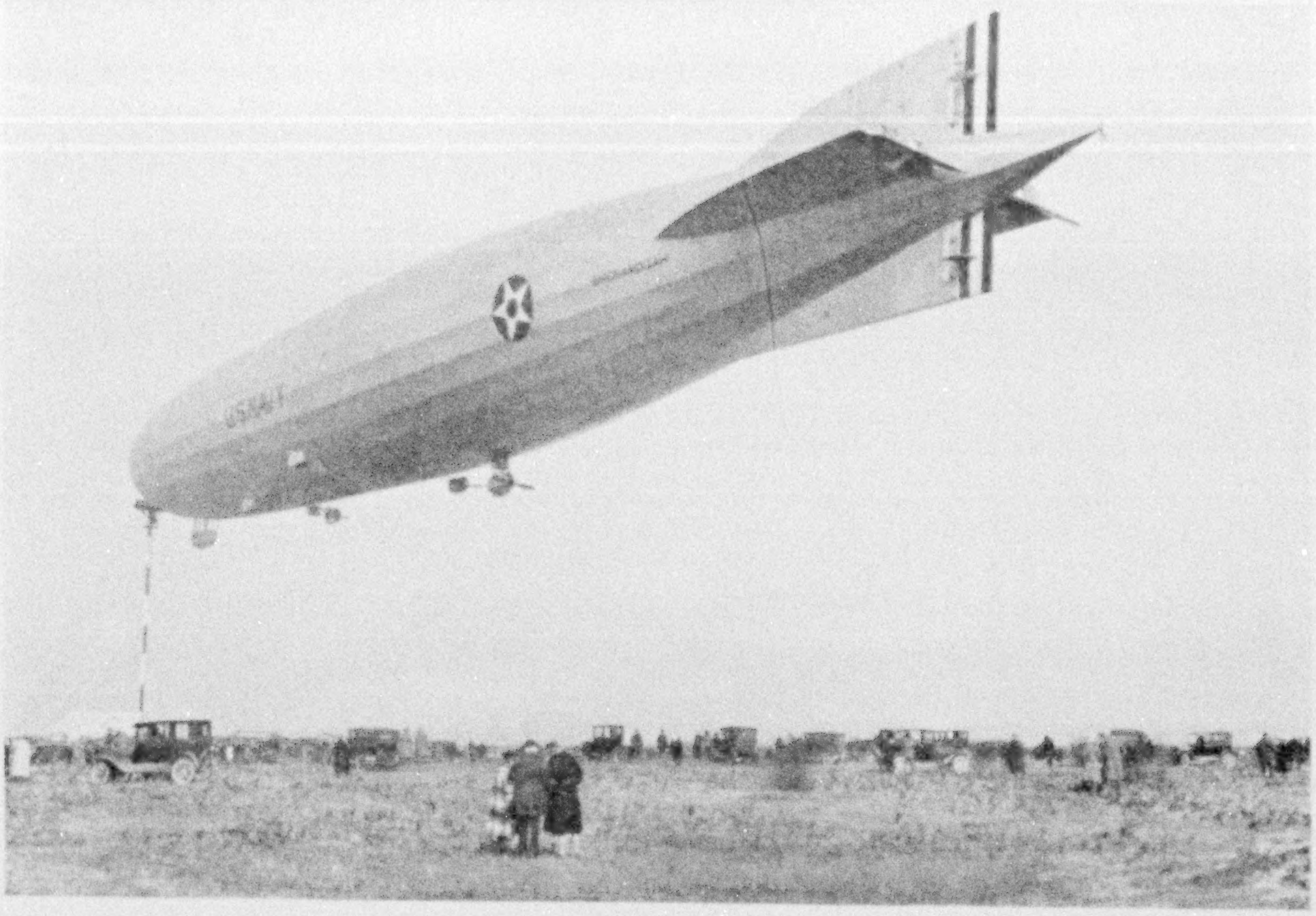
HOW THE "SHENANDOAH" IS BUILT

The crumpled girder was replaced while the ship was at the mast, 150 feet from the ground. All the parts were hauled up by hand. Only two men could work in the cramped quarters at the same time. Five days were necessary, but it showed that major repairs could be made at a mooring mast.

The silvery covering of the tube is stretched over a skeleton of triangular-shaped, latticed girders of duralumin, which is one-third the weight of steel.

The *Shenandoah* was built on the plans of the Zeppelin *L-49*, which came down in the American area in France. Her structural strength was increased, which adds to the weight, but which stood in good stead through the Rockies. An additional frame was added in the center, increasing her length and making possible an increased lift by another gas cell, but not improving her stream line or speed.

The five engines which carried the



Photograph by Boland

THE TETHERED LEVIATHAN OF THE SKIES

In the sunshine over the fog, at Tacoma, the *Shenandoah* was two tons light, and before mooring cruised for 10 hours at 40 miles an hour to keep down. Green Lake was the farthest north of the ship's voyage, and for any airship over the American Continent.

Shenandoah through the mountains are each of 300 horsepower, the two forward, close under the tube, with direct-drive, 11-foot propellers, and the remaining three with propellers 18½ feet in diameter. Two of these are reversible and water-recovery condensers are on three of the motors. They recover from 110 to 122 pounds of water ballast from every 100 pounds of gasoline consumed (see also "Man's Progress in Conquering the Air," in THE GEOGRAPHIC for July, 1924).

The *Shenandoah's* gas cells have a displacement of 2,148,070 cubic feet. Under certain barometric conditions, if filled with hydrogen, they would lift 150,365 pounds, and with helium 85 per cent of that, or 128,884 pounds. As the gas starts to expand as soon as the ship rises, it seldom is more than 85 per cent filled. Under such conditions, the lift of the helium-inflated *Shenandoah* is 109,551 pounds.

The dead weight of the ship, when dry and without water, gasoline, or oil, is 82,000 pounds. This cannot be changed, and the ship must be lightened from the "disposable," in distinction from the "useful," load. The 15 per cent reduction in inflation means a 40 per cent reduction in the entire load, as well as 40 per cent less than what an 85-per-cent-full hydrogen ship could lift.

Helium is safe and the *Shenandoah* has demonstrated that it is practicable. Its cost is the principal argument against its use. A single minute's valving to descend may lose from $2,000 to $3,500 worth of the precious gas.

THE START UP THE PACIFIC COAST

The weather was raw and hazy, with head winds down the coast, when the *Shenandoah* cast off from the San Diego mast at 9:15 a. m., October 16. Fifteen minutes later she had rounded Point Loma and was headed northward, over the Pacific Ocean, and 5 miles offshore. The battle fleet was at target practice, shots ricocheting across the surface with splashes a mile apart, in San Pedro Channel, off Catalina Island, at 12:15 p. m.

Greetings were exchanged between Ad-

Photograph by Junius B. Wood

THOUSANDS WAITING TO SEE THE AIRSHIP CAST OFF FROM CAMP LEWIS, WASHINGTON

After crossing Tacoma, the *Shenandoah* circled over Seattle and Green Lake. Then the big ship turned back, saw the fish traps in the tip of the Hood Canal, and sailed an hour over the drear Skokomish Indian Reservation, whose virgin forests, cleared circles furrowed by fallen pines, homes, and farms along the streams made a pictorial story of growing civilization from the forest and chase to industry and the farm (see text, page 42).

miral S. S. Robison, commanding the fleet, and Rear Admiral Moffett, the first of such high rank to make a cruise by air.

The *Shenandoah* circled inland over Los Angeles, skirted Hollywood at 1:10, passed over Santa Monica five minutes later, and was again out over the Pacific.

Picturesque Santa Barbara, white surf breaking below, mountains in the distance, and a string of automobiles on the winding road, was on the starboard side at 3:40. Dusk was falling over the lighthouse and white-fringed rocks of Point Conception at 6:07 p. m. Point Arguello was off the bow at 7 p. m. and the course laid out to sea, straight for Point Piedras Blancas, which was turned at 10:55. Point Sur Light was sighted at 1:17 a. m., October 17, and Point Cypress at 1:55.

Farallon Light was to port at 6:15, but San Francisco, 30 miles away, was invisible in the fog. Point Reyes was turned at 7 o'clock, the town of Mendocino at 11:34, and Fort Bragg, with its peaked-roof redwood lumber mills, at 11:55 a. m.

Point Delgada was reached at 1:04 p. m., and Cape Mendocino, a graveyard of ships of the sea, with its bobbing lightship, at 2:50.

When Admiral Moffett had charge of lighthouses a sleepy skipper told his Scandinavian wheelsman to steer straight for that lightship. He obeyed, and the captain was awakened by the crash, as his craft cut the lightship in two.

Thousands of seals, basking on Sugar Loaf Rock, off Cape Mendocino, flopped into the water as we passed.

Dogs, whales, and pelicans seemed the only denizens of earth, water, or air which were not terrified by the ship. Dogs barked, while other live stock ran; a pelican followed the ship's shadow on the surface as if it were a possible fish, while the whales played with it for miles.

Eureka and the Eel River valley were

Photograph by International

THE RETURN FLIGHT OVER SAN FRANCISCO

On the home-coming trip from the north, the *Shenandoah* "crossed Drakes Bay, where Sir Francis refitted his ships, but failed to discover San Francisco harbor, and sailed over the Golden Gate at 3 o'clock. She swung across San Francisco and was over the Pacific again by 3:30" (see text, page 42). Drakes Bay, a few miles to the north of Stow Lake, was discovered in 1579.

near at 4 o'clock, and at 7:35 p. m. Brookings, Oregon, was opposite and the California coast had been left behind. The rising moon was silvering the sky back of the mountains and lights were flashing at the black mouth of the Rogue River at 9:10 p. m., and at 12:30 a. m., October 18, the ship turned inland over Florence, Oregon, up the Siuslaw River valley, turning northward again in the Willamette Valley, about 15 miles north of Eugene, at 1:58 a. m. It passed between Corvallis and Albany at 2:25, over Salem and the lights of the capital at 3:10, Silverton, with two red flares, at 3:15, and was invisible in the fog when the lights of Portland glowed below, at 4:16.

CRUISING TEN HOURS TO SAVE HELIUM

The radio telephone told the ship that it was over the mooring mast at American Lake, a part of Camp Lewis and about 10 miles south of Tacoma, at 8:15 a. m. As far as the eye could see, there was a solid floor of fog, the peaks of Hood, Rainier, and Glacier, of the Cascade Range, like sentries on a 200-mile front, to the east, and the tip of a single smokestack, the second tallest in the world, to the west.

The mooring mast was invisible, and in the sunshine, over the fog, the ship was two tons light. It cruised at 40 miles an hour to keep down, but did not moor to the mast until 6:30 p. m., October 18.

With the enforced time-killing to avoid valving helium, the voyage north against the head winds had taken more than 57 hours. It was the most monotonous leg of the entire cruise. Smoking is tabu on the ship. A dry smoke, plug, or chewing gum is the only consolation. Smoking one cigar for 57 hours, with an inch unconsumed at the end of the trip, is almost a record.

The Sunday sun was late in rising in Tacoma, and it was 12:05 p. m., October 19, before the *Shenandoah* cast off from the Camp Lewis mast on its return voyage. Tacoma was crossed at 12:25 and the ship circled over Seattle from 1:00 to 1:20. Green Lake, at 1:05 p. m., was the farthest north of the voyage or for any airship on this continent. Admiral Moffett was on the hill of the Bremerton navy yard, with the *Mississippi,* which he once commanded, below and the *Shenandoah* above, at 1:35. The fish traps in the tip of the Hood Canal were on the right at 2:20.

A PICTORIAL STORY OF GROWING CIVILIZATION

For the next hour the *Shenandoah* was sailing over the drear Skokomish Indian Reservation, with its virgin forests, its cleared circles furrowed like big chrysanthemums by the fallen pines, little homes springing up and prosperous farms along the streams—a pictorial story of growing civilization from the forest and the chase to industry and the farm.

Hoquiam was passed, at 3:25 p. m., and we turned southward over the Pacific at 3:47.

A detour was made into the mouth of the Columbia River and over Astoria at 4:40 p. m., but the insistent radios from Portland for another visit could not be acceded to. Lieutenant J. B. Anderson, aërologist aboard, forecast another storm for the coast. He always prophesied head winds. There were no pleasant surprises. He always was right. To meet the full force of this storm would bring slower sailing, and Portland might mean a couple of hours' delay.

Cape Lookout was passed at 6:12 and Cape Arago, in a thick fog, at 9:10 p. m. Cape Mendocino Light was sighted at 1:55 a. m., October 20; Punta Gorda at 2:30, Fort Bragg at 4, and after that everything disappeared in the fog. Beneath it could be heard the sirens of steamers, and through the chasms in the solid mantle of white came glimpses of white-capped waves, surf breaking on rocks, and once of a ship rocked by the storm.

SAN DIEGO MAST LOST IN A FOG BANK 1,000 FEET DEEP

At 8:15 the fog had disappeared and the *Shenandoah* was facing a 50-miles-an-hour gale off Point Arena. For an hour the rocks of the point stuck by her side. Bodega Head was reached at 12:30 p. m., and Point Reyes at 1:55. Only 68 miles had been covered in 5 hours and 40 minutes.

With another struggle she rounded the last rocky head, changed course at Duxbury Point at 2:30, crossed Drakes Bay, where Sir Francis refitted his ships, but failed to discover San Francisco harbor, and sailed over the Golden Gate at 3 o'clock. She swung across San Francisco and was out by San Mateo and over the Pacific again at 3:30.

Monterey was passed at 3:58, Point Sur at 7:41, Point Piedras Blancas at 8:50, Point Arguello, where the skeletons of seven destroyers lie, at 10:32, Santa Barbara at 11:45, the fleet anchored off San Pedro at 2 a. m., October 21, and the San Diego mooring mast at 4.

The mast was unseen and unheard under the fog bank, 1,000 feet deep. When the first pink flush of dawn showed the black peaks of Mexico over a snow-white world, the *Shenandoah* was 20 miles south of the border. She doubled back until Table Mountain, in Mexico, was sighted, at 7:30 a. m.

The ship was becoming lignter under the sun and Commander Lansdowne drove her at 50 miles an hour through the fog, cooling the gas in the mist. Canyons, mountains, and valleys of fog were below when she rose again. The compass station on Imperial Beach was giving

Photograph by Junius B. Wood

WHERE SOIL IS FERTILE AND FARMS ARE CLOSE: NEAR RICHMOND, INDIANA

"From the skies the undulating earth seemed covered with carpets in drab and green and rugs of bright colors, cut into squares and strange shapes, and marked with strings of white, which were highways." Chickens and cows are scurrying for cover as the *Shenandoah's* shadow skims over Richmond, in the famous Whitewater Valley, on the Old National Road.

bearings by radio almost every minute, but the one on Point Loma was silent, closed by an economical government. The ship could tell that it was on a line, but without the cross-bearing from another station could not locate the exact point.

At 9:03 the fog started to burn off. Point Loma suddenly jumped into view, seemingly only a few feet under the bridge, at 10 o'clock. The ship landed on the field at 10:55 a. m. and was moored to the mast at 11:40.

Rear Admiral Moffett had left the ship at Camp Lewis. Captain Stanford E. Moses, commander of the air squadron of the battle fleet, and Lieutenant Commander R. D. Kirkpatrick, battle fleet aviation officer, had made the voyages between San Diego and Tacoma. Joe Johnson, the movie operator, made the northbound voyage.

Captain Thomas T. Craven, commander of the San Diego station, came aboard at San Diego. No more passengers could be risked for the trying trip over the mountains.

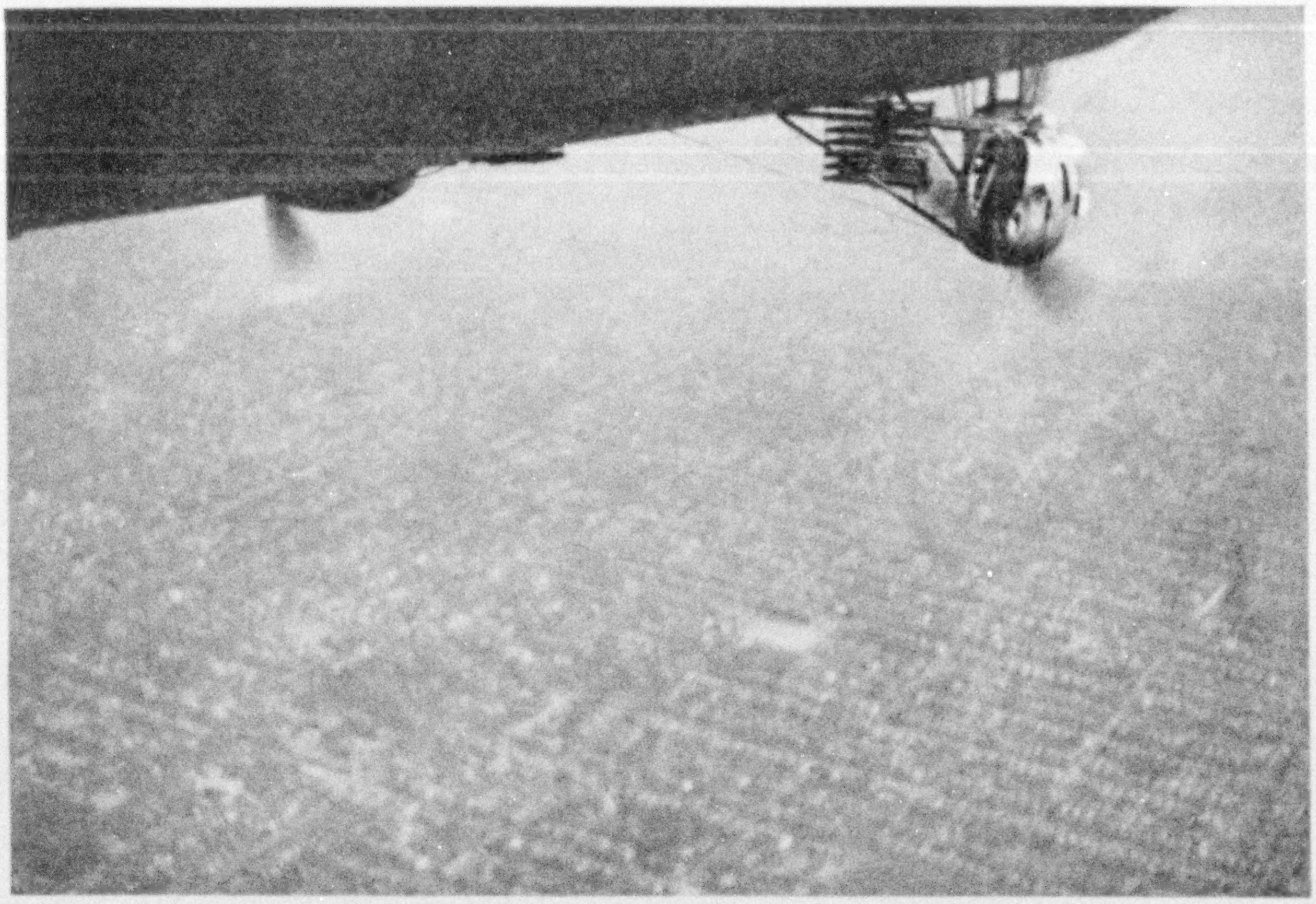
The *Shenandoah* cast off from San Diego at 11:07 a. m., October 22, headed south toward Tia Juana, circled between the Otay reservoir and the city to warm up and increase her buoyancy, to get an altitude of 6,000 feet before crossing the first cordillera of the Rockies. She was going south of the Salton Sea.

With 18,000 pounds of fuel aboard, she was heavy and her motors were driving full speed, 1,400 revolutions a minute, while her length tilted upward at an angle of 12 degrees in order to stay in the air.

BREASTING AIR WAVES 1,000 FEET HIGH

Machinist S. C. Halliburton, the assistant engineer officer, clambered down on to the "bridge" twice, with shivery suggestions about the possibility of ending the trip on the side of a mountain.

Sailing was bumpy, and the heavy ship was gliding on the swirling air waves in dips which the altimeter showed were



Photograph by Junius B. Wood

MOTORS ROARING OVER COLUMBUS, OHIO

The propeller of the starboard motor is making 1,200 revolutions a minute, which is standard speed. The port forward motor can be partially seen under the ship. The water-recovery apparatus on the *Shenandoah* consists of several tiers of long, light pipes, exposed to the cooling air, so that the superheated steam condenses and fills water tanks. This American invention is installed on three of the motors, recovering from 110 to 122 pounds of water ballast for every 100 pounds of gasoline consumed.

nearly 1,000 feet between trough and crest. It was the same during the next day over Ohio—no roll, but a pronounced tip to decks and runway.

"She's 5,000 pounds heavy and tipped all she can stand, and engines going full speed," Halliburton insisted.

"Do you want to spill fuel?" Commander Lansdowne asked.

Halliburton again referred to the desirability of finishing the trip in more homelike surroundings.

"Not just yet," Lansdowne decided.

GASOLINE TANKS EMPTIED TO KEEP AFLOAT

Cottonwood was below at 12:25 p. m.; Campo, 12:50, Jacumba, where the last emergency water ballast was dropped on the corrugated tin roofs, at 1:00; Coyote, the first city in the Imperial Valley, 1:40; El Centro, with Calexico and Mexicali, in Mexico, seeming only a few feet away, 2:01; Yuma, Arizona, three miles to the south, 3:10; Mohawk, 5:20; Aztec, 5:46; and Gila Bend, 6:55.

More than a mile above sea-level, the gas was cooling rapidly in the heavily loaded ship. Two gasoline tanks were jettisoned of their contents and another was dropped outright farther on.

The night was cool, and even with a ton of ballast gone the motors were forced to drive her at an angle to maintain the altitude. Enid was recognized at 7:30; Maricopa, 7:50; Casa Grande, 8:15; Tucson, 10:00, and the course was changed to the southeast west of Benson at 10:41.

Near Naco, along the border, the faint moon disappeared. The ship slipped over a mountain, picked up the railroad track, and a few minutes later was over a brilliant city nestling in a bowl of the Mule Mountains, with black peaks on three sides. It was Bisbee, and railroad and valley ended.

"She's tilted to 13 degrees and can't

do any more," Halliburton declared, as he clattered through the metal door and down the ladder.

The motors were straining to the limit. If one had missed, she would have dropped on the mountain side, rapidly coming nearer. Another tank of gasoline was dropped and she rose to 7,300 feet, turned over Bisbee and its mountain walls at 12:40 a. m., October 23, and was going so fast when Naco was sighted ten minutes later, that she was in Mexico before she was able to swing around again to the eastward.

RADIO WHISPERS OF TRAGEDY

The danger was passed. Clear sailing was ahead. Hunched over his key and dials in the radio shack, "Mr. Sparks" resumed his interminable experiments; testing, picking up messages here and there and trying to get stations thousands of miles away. Suddenly his heart jumped as the headpieces, clamped to his ears, ticked out the fragment, "—— in the explosion automobile burned. Both dead."

That the 724-pound gasoline tank had hit an automobile when it crashed to the ground and burst into flames flashed through his mind. The catastrophe had happened. No need to alarm the other officers. Frantically he worked at his key to locate the station which had sent the message. It was gone. No answer came. Other stations came in but knew nothing. He persisted, groping through the air. Then out of the clear, after what seemed an age, came another message, "Man arrested here confesses automobile accident."

This time he located the station. It was several hundred miles from the course of the ship. He took off the headpieces and realized he was perspiring. Even up in the chill clouds the cabin seemed stuffy. He opened the door and looked out. Aft the motors were roaring as if alive, 3,000 feet below the earth slept under the moonlight. It seemed like a nightmare from another world.

Douglas was passed at 1:27 a. m.; Rodeo, New Mexico, 2:30; Hachita, 3:47; Hermanas, 4:40; Columbus, of Villa infamy, 5:21; El Paso, Texas, 9:00 (central time); Fabens, 10; Fort Hancock, 10:45; Sierra Blanca, 11:40; Van Horn, 12:45 p. m.; Pecos, 3:14; Odessa, 5:05; Midland, 5:34; Big Spring, 6:26; Colorado, 7:27; Sweetwater, 8:06; Abilene, 8:57; Fort Worth, 1:30 a. m., October 24, and moored to the mast at 2:27.

The fuel ballast lost in the mountains had killed hopes of a non-stop flight across the continent. If the first night had been less cool or the winds more favorable, it might easily have been made, so much influence do heat and wind have on the sailing time of an airship. However, the return was by the rougher northern route.

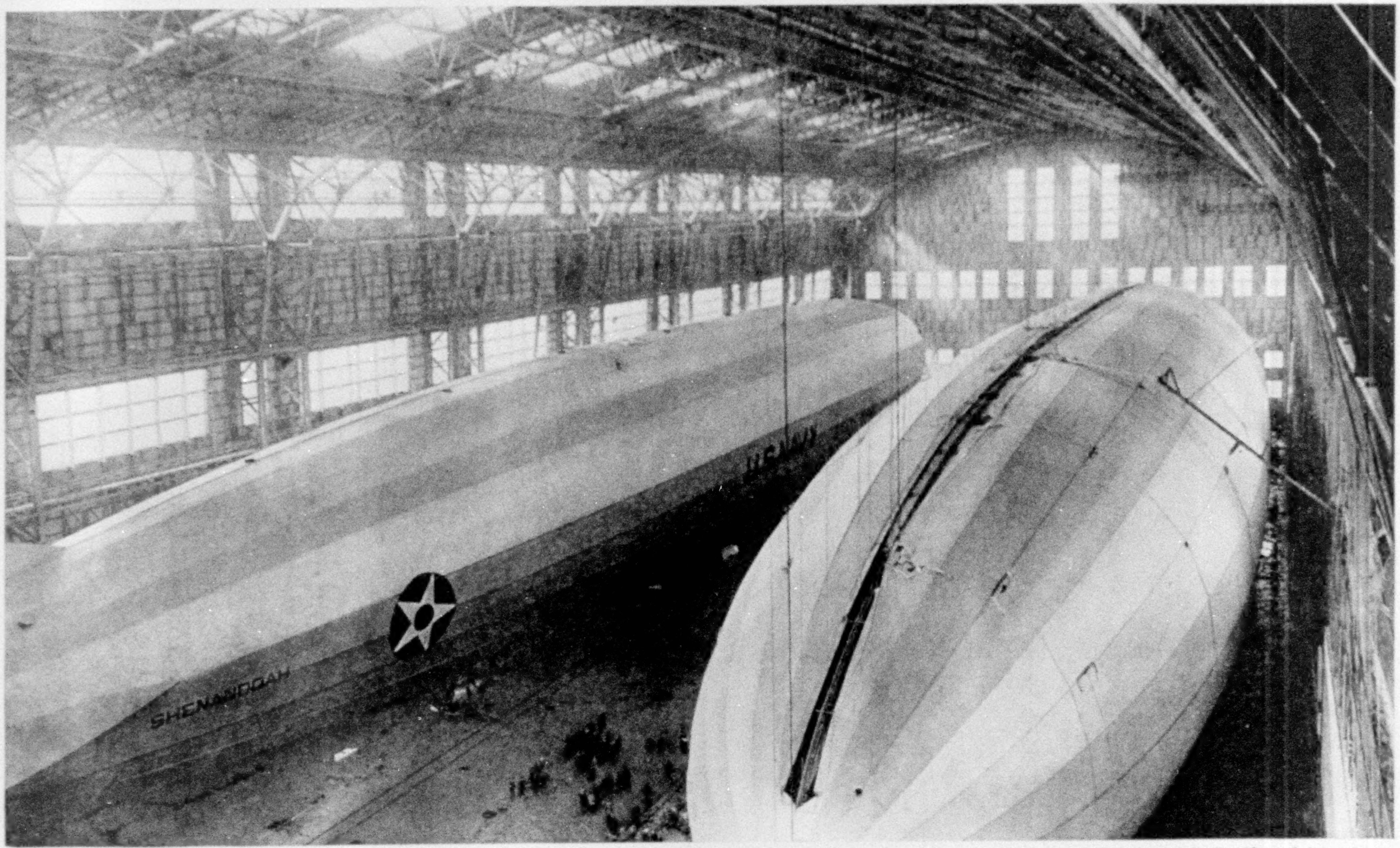
The Fort Worth mast was left at 10:33 a. m., October 24, with 16,296 pounds of fuel aboard. Dallas was passed at 11:30; Rowlett at noon; Greenville, 12:48 p. m.; Clarksville, 2:55; Morris Ferry, Arkansas, 4:17; Lockesburg, 4:45; Hot Springs, 6:57; Little Rock, 8:17; Newport and the White River, 10:25; Jonesboro, 11:55; the Mississippi at New Madrid, Missouri, 1:46 a. m., October 25; Paducah, Kentucky, 3:39; Evansville, Indiana, 5:17; Columbus, 8:00; Richmond, 9:30; Greenville, Ohio, 9:55; Dayton, 10:38; Springfield, 11:15; Columbus, noon; Zanesville, 1:06 p. m.; Moundsville, West Virginia, 2:30; Waynesburg, Pennsylvania, 4:10; Chambersburg, 6:28; York, 7:25; Chester, 9:00; Philadelphia, 9:40, and Lakehurst, New Jersey, 11:00, landing on the ground facing the hangar at 11:55.

THE "SHENANDOAH" COMES TO REST BESIDE THE "ZR-3"

An hour later the $2,000,000 *Shenandoah* was berthed in the $3,600,000 hangar, at the side of the fat *ZR-3*, a sailing palace compared to the strictly utilitarian American-built airship.

America's first venture in rigid airship building with its American crew had made the longest cruise of any dirigible from a home base, was the first to see the Pacific or the Northwest of the United States, and had proved that mountains are not a barrier to the big ships, and that helium and mooring masts, which the Zeppelin-seasoned builders and navigators scorn, are practicable.

The same storms which the *Shenandoah* rode through on the Pacific had



Photograph by Pacific and Atlantic

THE "SHENANDOAH" AND THE "LOS ANGELES" SIDE BY SIDE IN THE LAKEHURST HANGAR

Though the *Shenandoah* is purely a military type of rigid airship, its transcontinental cruise blazed the way for commercial rigid ships, of which the *Los Angeles* (*ZR-3*) is the forerunner. Though the former is 24 feet longer than the latter, it is smaller in diameter and, therefore, in gas capacity. The Lakehurst hangar is the largest "single room" in the world, and could house three Woolworth buildings, lying side by side. It represents an outlay of $3,600,000.

sent ships on the rocks and others to dry docks for repairs.

THE CREW ON THE HISTORIC TRIP

Structure and engines had stood the test, but the cruise could not have been made without the skill and tireless energy of the officers and crew. The enlisted men, nearly all with the grade of chief petty officer, were: F. J. Tobin, Arlington, Massachusetts; F. E. Masters, Akron, Ohio; C. A. Heckbert, Rockland, Maine; R. B. Boswell, Pensacola, Florida; E. P. Allen, St. Louis; L. E. Allenly, Logan, Ohio; A. E. Carlson, Moscow, Idaho; J. F. McCarthy, Dorchester, Massachusetts; F. L. Peckham, Humboldt, Iowa; J. H. Collier, Oklahoma City, Oklahoma; R. E. Deal, Quincy, Massachusetts; E. B. O'Sullivan, Lowell, Massachusetts; Amos Barton, Kansas City; J. W. Cullinan, Binghamton, New York; W. A. Russell, New York City; C. W. Broom, Atlantic City, New Jersey; L. K. Coleman, Fort Worth; L. W. Owen, Minneapolis; T. Dickerson, Los Angeles; R. Jones, Los Angeles; W. N. Spratley, Philadelphia; C. P. Mazuco, Staten Island, New York; J. F. Moorman, Buffalo, New York; T. A. Knight, Little Rock, Arkansas; August Quernheim, St. Louis; C. S. Solar, Toledo, and J. J. Hahn, Philadelphia.

Masters remained in San Diego, recovering from an operation for appendicitis, and Broom returned with a broken wrist from cranking his engine in Fort Worth. Cuts and ills of the others were salved by the iodine and salts of the musette-bag medicine chest.

Eleven of the men were riggers—six wheelsmen and five in the keel; fifteen were machinists—twelve on the motors and generator and three in the keel—and Hahn was the cook, the only flying cook in the Navy. When he stepped on a nail in San Diego, 300 volunteered for the place, but he recovered. He worked 22 hours a day, heating coffee, soup, and beans, carrying it up the little ladder, and serving 4,175 superannuated sandwiches and 2,300 cakes of chocolate during the cruise, each with a double shuffle and flourish worthy of a French chef.

"How long ago did we pass San Francisco?" Hahn asked that blustery morning when everybody aboard had about given up hope of ever seeing San Francisco, so absorbed was he in his cooking.

The digest of the cruise, giving the time in hours and minutes, shows:

From Lakehurst	In flight.	In air.	Moored.
To Fort Worth	36:45	38:05	10:41
To San Diego	39:14	41:14	128:15
To Camp Lewis	47:15	57:55	16:55
To San Diego	39:55	47:35	23:25
To Fort Worth	36:25	37:22	8:06
To Lakehurst	35:27	36:22	-----
Totals	235:01	258:33	187:22

The cruise of the *Shenandoah* was over an uncharted world. Beacons by sea and signs by land have been built through the ages for those who voyage on the surface. A new era of transportation is coming nearer, in which the airship will have a place as a conveyance of peace as well as an instrument of war. Many lessons were learned on the *Shenandoah's* cruise.

The American-built and American-manned airship in that cruise showed that mountains and distances are easily negotiable. It also tested the practicability of the American innovations which have been added to the plans Count von Zeppelin laid down.

The voyage to the North Pole and the exploration of the vast unknown polar regions have been made nearer realization by the *Shenandoah's* venture in the face of a blustering autumn. With the springtime, polar flights may come and the world's most inaccessible region will be within easy reach of man.

The United States now has two great airships, small when compared to those of 5,000,000 and 6,000,000 cubic feet displacement, which are planned, but which have already demonstrated their airworthiness and capability for the rigors of polar exploration.

© Ewing Galloway

THE BEAUTIFUL MAIN GATE TO THE PALACE OF VERSAILLES

This is the entrance from the Place d'Armes, through which most visitors pass. At the right may be seen the Grande Chapelle and three of the enormous statues erected in the reign of Louis Philippe.

THE PALACE OF VERSAILLES, ITS PARK AND THE TRIANONS

By Franklin L. Fisher

As THE tired and travel-worn visitor arrives at the gates of the Palace of Versailles and passes through under the gilded arms of France, he enters the *Cour d'Honneur* and sees facing him the great equestrian statue of Louis XIV, the *roi soleil,* that august monarch who occupied the throne of France for 72 years.

Guarding the court in impressive grandeur are statues of distinguished statesmen and marshals, like giants of old, and even across the vast expanse of cobblestones stretching in every direction these honored of France appear of heroic size.

At either side and in front rise the impressive walls of "the architectural masterpiece of the most brilliant era of a great nation," later transformed by King Louis Philippe (1833-37) into a museum "to all the glories of France."

This is the first view of the palace as seen by the majority of travelers from other lands, who make of it a goal of artistic pilgrimage, a place of historic curiosity, or merely one of the sights of the country, depending upon the visitor and his cultural interests.

The patrons of art come to see the creations of the architect Mansart, the murals and decorations of Le Brun, the portraits by Mignard, the sculptures of Coysevox, and the landscape gardening of Le Nôtre, whose design of the extensive park has been kept almost intact throughout the vicissitudes of the passing years.

For the students of history the shades of such personages as the "Great King" and his successors, who made this their home and seat of government until the Revolution—Molière, Mesdames de Montespan, de Maintenon, de Pompadour, du Barry, and Queen Marie Antoinette—flit through the scene attired in the costumes of the romantic long ago.

Before the eyes of those blessed with a bit of imagination the grand fêtes, which characterized the royal life of the time and by their extravagance kindled the fires of revolution, are reënacted in all their magnificence.

The intrigues of the court, so frequently appearing in literature and upon the dramatic stage, are brought to mind and the frivolities of the pleasure-mad nobility are once more rehearsed. The concourse is again thronged with a ragged populace brandishing aloft crude weapons and shouting demands for food and for death to their King and "The Austrian."

THE ENTRANCE AN ENDLESS OCEAN OF COBBLES

To the casual tourist this grand entrance is a bit forbidding, and he peradventure views with the apprehension that comes to tired feet the seemingly endless ocean of cobbles under the glare of the sun. He feels in his pocket to make sure that there is at hand the necessary small change to meet the requirements of guides and to purchase the usual stock of postcards which he will laboriously indite to the envious folks at home.

Bulging in his side pocket will be his red-backed guidebook, by which he will presently endeavor to follow the French-English discourse of his mentor. Over his shoulder hangs his kodak, ready for the instant recording of yet another film with which he will later proudly prove these wonders in his native land.

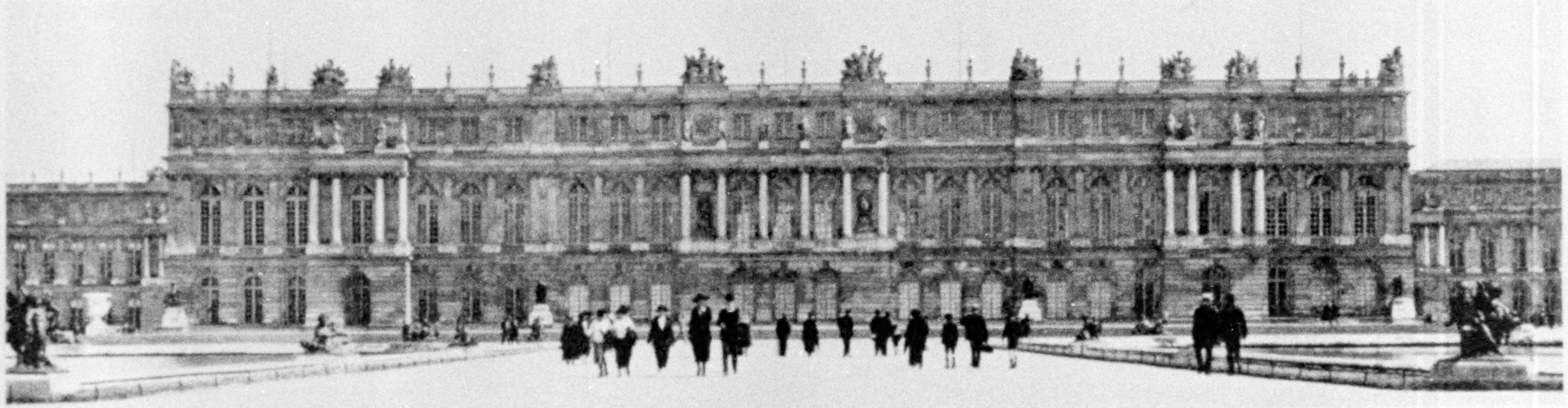
The Grande Chapelle, which attracts instant attention upon arrival within the gates, was designed by Mansart, who obtained some of his ideas for it from the Sainte Chapelle in Paris. Louis XIV, having become devout in his later years, "determined to raise that monument of his piety."

In the hundreds of rooms in the palace it is said that 10,000 persons could be housed, and although the facts of the cost of this magnificent creation can never be accurately known, it has been estimated at $100,000,000, which, considering the period and the methods employed by an absolute monarch, is tremendous, even in these eight-hour days.

Photograph from Franklin L. Fisher

THE PALACE OF VERSAILLES FROM THE PLACE D'ARMES

Great spaces enhance the grandeur of Versailles, and the Place d'Armes, upon which the three wide avenues de Sceaux, de Paris, and de St. Cloud converge, is of vast expanse.



Photograph by Ewing Galloway

THE PALACE FROM THE PARTERRE D'EAU

The mirror pools with their marble curbs and their groups of statuary in bronze are seen at either side. The three windows at each end of the second story are those of the Salons de la Guerre and Paix, between which are the seventeen famous windows of the Galerie des Glaces.

The architecture is of the most eye-filling style and the interior furnishings were the *dernier cri* in luxury. A hundred sculptors are said to have been employed to provide the statuary which decorated the gardens as well as the palace itself, and painters beyond count executed masterpieces to adorn its walls and ceilings.

"The double attraction of art and history gives this palace a rare prestige. There is no princely dwelling in Europe that combines so many glorious and interesting memories in a setting of such perfect beauty."

VERSAILLES THE MODEL FOR THE EX-KAISER'S PALACE

It was Versailles which furnished the model for the palace of Sans Souci at Potsdam and other less widely known German palaces, the Schönbrunn at Vienna, the Wren portion of Hampton Court in England, and many others throughout Europe.

Just as Louis XIV made of Versailles the center of interest of his France by the brilliance of his court, and attracted to it those nobles of his country who might have made more trouble for him had they remained at home, it had been the policy of the Bourbons, initiated by Henry IV, to call to France the artistic industries of other countries. The effect of this policy is to be seen even to-day in the artistic productions of the French.

Flemings and Italians who excelled in the finer arts were induced to make their homes in France and to act as teachers to the artistically inclined. In this manner the royal manufactories of tapestries, carpets, furniture, and porcelain were established and the designs of the foreign masters gradually modified and adapted to produce the French classic style.

Colbert, the great minister of Louis XIV, who was bequeathed to him by Cardinal Mazarin, organized an academy of architecture. There was also an academy of painting and sculpture, and even a French academy at Rome had been established to provide further facilities for the art students to see the masterpieces of the Greeks and the Romans.

This policy of encouragement and royal assistance bore glorious fruit. The Palace of Versailles, in its building and decoration, supplied a wonderful atelier for an early expression on a large scale of the genius developed and trained in this manner.

LOUIS XIV CONCEIVES OF A MASTER PALACE

Versailles was not made in a day; its construction continued throughout the reigns of three successive kings. It may be said to have been the conception of Louis XIV, however, for it was he who had the vision of it almost in its entirety, and much may be accomplished in a reign the length of his.

Perhaps his inspiration grew from envy, for it was his first idea to provide a setting for fêtes which would outshine in magnificence and extravagance those of his embezzling superintendent of finance, Fouquet, who had first employed the master landscape gardener, Le Nôtre, to design his own gardens at Belle Ile, where the King had been entertained soon after he had taken over the reins of power.

With his own hand Louis is said to have drawn roughly the plans for Versailles, following designs submitted by Lemercier and Boyceau, and then to have given orders for their execution to the gardener, Le Nôtre; to the first architect, Le Vau; to the painter, Le Brun, and to the sculptor, Coysevox, all of whom worked under royal supervision and were directed by Colbert.

Pierre de Francine, who was skilled in the construction of waterworks, designed the system by which the numerous fountains and pools are still fed with sparkling water from the great reservoirs of Montbauron and Gobert. He received the title of Commander of the Fountains.

The Keller Brothers, who cast the King's cannons at the Paris arsenal, also cast the bronzes designed by the sculptors after suggestions by the King and Le Brun. In short, the foremost artists of France combined to make of this place "the most beautiful spot in the world."

The Palace of Versailles was built around the hunting lodge of Louis XIII, the walls of which still inclose the Marble Court, while the gardens were cut out from the earlier king's estate.

Much of the ground was low and the

earth of the terraces was brought from afar. The necessary grading and leveling, the construction of the aqueduct, and the building of a road from Paris are said to have been the work of years by "all the King's horses and all the King's men," as the song goes, for 36,000 men and 6,000 horses were employed at the task.

WILLIAM I CROWNED EMPEROR OF GERMANY IN THE HALL OF THE MIRRORS

The most famous room, the *Galerie des Glaces* (Hall of the Mirrors), where the King of Prussia was crowned Emperor of Germany at the end of the Franco-Prussian War, and the Treaty of Versailles was signed in 1919, still retains much of its former magnificence, although its silver furniture was sacrificed to the mint when money troubles afflicted the Grand Monarch.

This room is lighted by 17 great windows overlooking the gardens, opposite which are a corresponding number of imitation arcades filled with 306 beveled Venetian mirrors, whose size and brilliance were wonders of their time.

When lighted by myriads of candles, the gorgeous scenes they reflected challenge description. On the vaulted ceiling of this and the rooms at either end, Le Brun painted a series of pictures illustrating allegorically the triumphs of his master's reign. In them Louis is represented as a Roman Emperor in golden armor. This is still the largest painting in France.

On the same floor are the rooms of greatest interest to the romantically inclined, the *Cabinets de Marie Antoinette.* They are small and consist of a boudoir, two libraries, a salon, bath and dressing room, and are adjacent to the *Grands Appartements de la Reine,* the state suite, the bedroom of which was occupied by the succeeding queens of France. Here were born many princelings, and, following ancient royal etiquette, these births took place in public, so that the people might be certain of the authenticity of their royal family.

The bedroom of the King is behind the center of the Hall of the Mirrors, its windows looking out upon the Marble Court toward the Paris gate. Its marble balcony will be remembered, for it was to this that General Lafayette, of our own Revolutionary fame, escorted Louis XVI to be seen by the mob, and where Marie Antoinette by her bravery changed their cry of "Death to the Austrian" to "*Vive le Roi! Vive la Reine!* Let us take them to Paris!"

It was in this room that Molière served as *valet de chambre tapissier* to Louis XIV, and made the King's bed that he might be near the master and thus obtain His Majesty's permission to stage his comedies at the court.

Below the windows of the Hall of the Mirrors, on the opposite front of the palace, is the terrace of the *Parterre d'Eau,* as the two limpid pools inclosed by marble curbs are called. Each of these natural mirrors is decorated with four recumbent statues in bronze which represent the rivers of France. These are masterpieces of sculpture and among the most important groups of bronzes in Europe. Each figure was made by a different sculptor from designs suggested by Le Brun and approved by the King. They were purposely made too large in proportion, so Louis could see them clearly from his windows.

Pierre de Nolhac, formerly Director of the Versailles Museum, who has written a delightful book on Versailles, says at the beginning of his chapter on the garden: "It was the condensed genius of a whole race that created this formal and orderly miracle of flower beds, sparkling water, and marble; this harmonious geometrical figure, to which the sunlight has lent its own dazzling magic."

Straight down the center of the garden are, in order, the Basin of Latona, the *Tapis Vert,* the Basin of Apollo, and the Grand Canal, while to left and right other fountains, lawns, and flower beds fill the visitor's eyes with their striking beauty and pleasing design. Walks lead in every direction and statuary in marble and bronze peoples the vast spaces, which are otherwise often almost deserted except upon fête days.

THE COLONNADE OF MANSART

Near the Basin of Apollo is a bit of striking architecture which has seemed to many rather out of accord with the general scheme of decoration employed throughout the gardens. This is the

© Autochrome Lumiere by Gervais Courtellement

BLINDMAN'S BUFF AS PLAYED IN THE TIME OF MARIE ANTOINETTE, QUEEN OF LOUIS XVI

Louis XIV created and beautified Versailles to provide an alfresco setting where he might outdo in splendor the fêtes given to the nobility by his superintendent Fouquet. The king himself planned the entertainments, the magnificence of which has ever been famous in court annals. Since the rehabilitation of Versailles, companies of players, dressed in costumes of the period, have often come to reënact the events of *le grand siècle*.

A SCENE AT SUNSET IN THE PARK

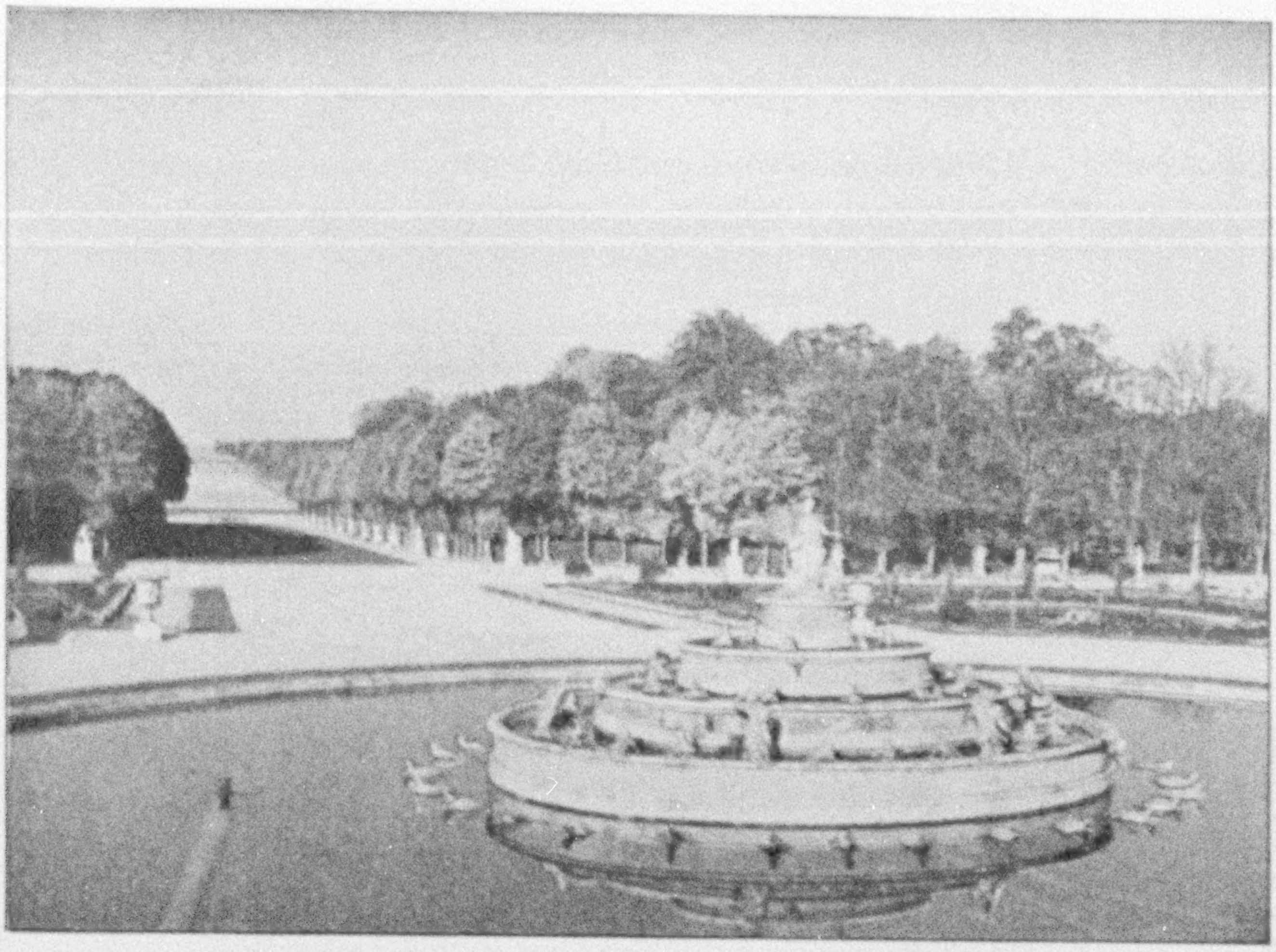
The gardens of Versailles fall away on every side from a terrace adorned with ornamental basins, statues, and bronze groups. Westward from the Château extends a long greensward avenue bordered with large trees. Of the great number of objects of art that adorned the spacious parks, but few have survived through the tragic years.

©

Autochromes Lumière by Gervais Courtellemont

AMONG THE FLOWERBEDS OF VERSAILLES

"It was the condensed genius of a whole race that created this formal and orderly miracle of flowerbeds, sparkling water and marble; this harmonious geometrical figure, to which the sunlight has lent its own dazzling magic." The formal gardens are essentially the same to-day as when first laid out in 1667-88.



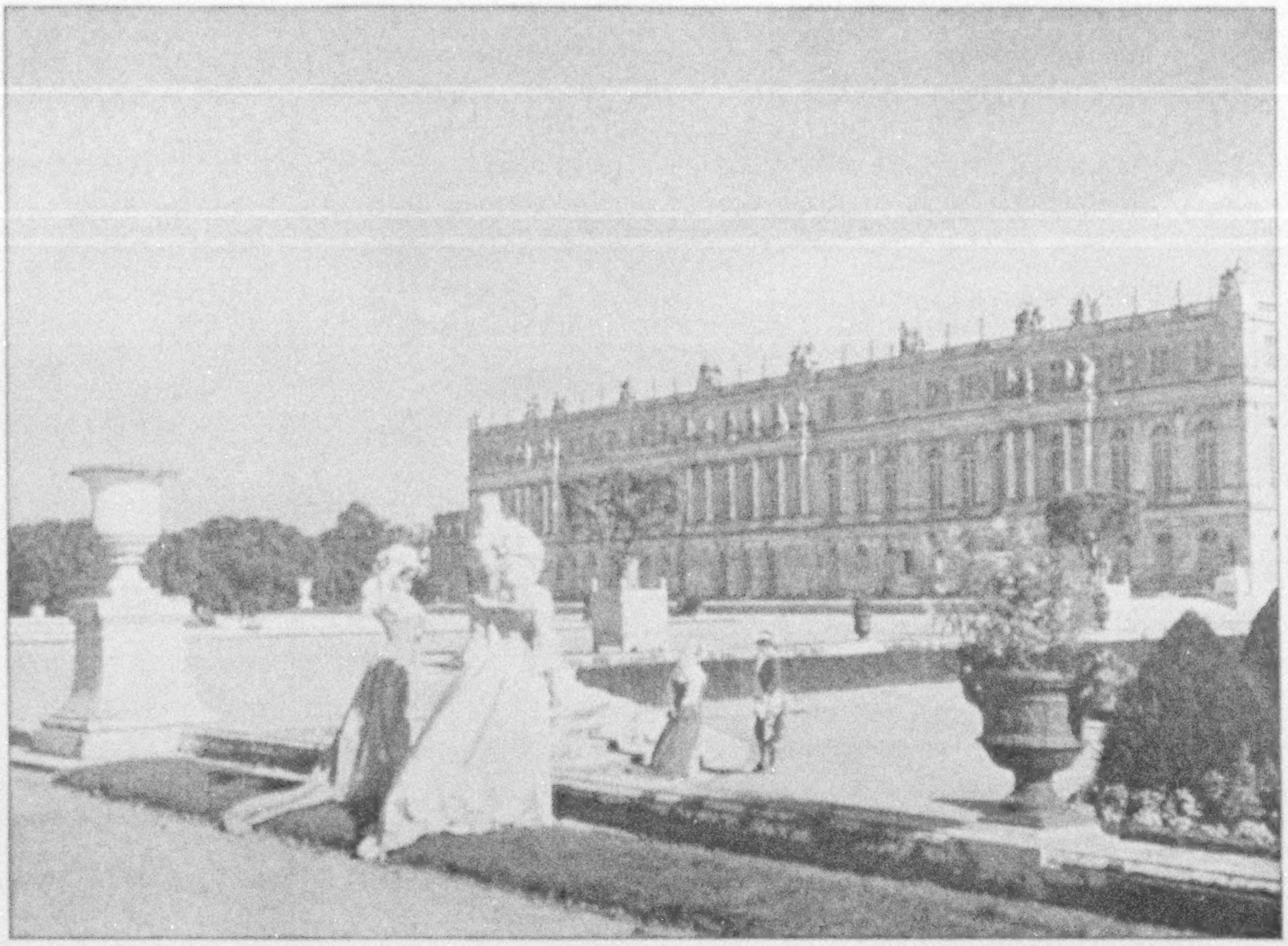
THE RED MARBLE FOUNTAIN IN THE BASSIN DE LATONE

Gilded tortoises, frogs and lizards spout water against a white marble group of the Greek goddess Leto (Latona) with her children, Artemis and Apollo. Statuary is arranged around the enclosure, and a glimpse may be caught of the grassy "Tapis Vert" leading to the Grand Canal in the distance.

© Autochromes Lumière by Gervais Courtellemont

THE CHÂTEAU OF VERSAILLES, FROM THE GARDENS

The stories about the creation of this palace and its gardens almost surpass belief. It is said that 36,000 men and 6,000 horses worked for years in preparing the ground for the gardens and park, in making a road to Paris, and bringing water to the gardens, the soil of which covers innumerable pipes, vaults and aqueducts.



THE ARCHITECTURAL TRIUMPH OF THE "GREAT REIGN"

This palace, designed by Louis XIV as a symbol of his reign and as a monument to his greatness, originated in a hunting lodge built for Louis XIII. When its vast additions were completed, it housed thousands attached to the court. The long façade, toward the gardens, has 375 windows, and overlooks far-flung avenues and enchanting lawns.

©

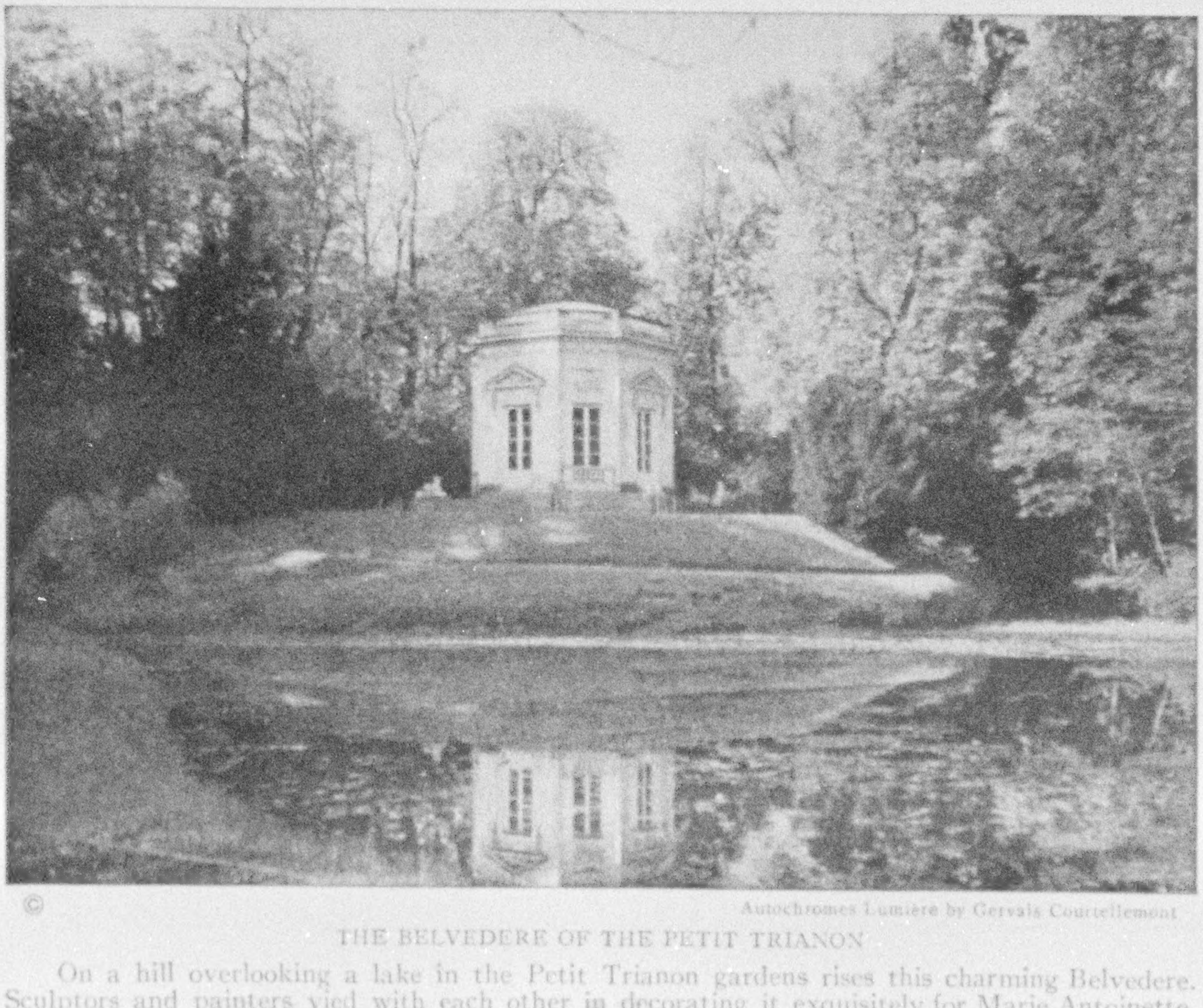
Autochromes Lumière by Gervais Courtellemont

A VISTA IN THE GARDENS OF VERSAILLES

The grand architectural lines of the Château are continued in its gardens, the master plan of Le Nôtre, the famous landscape-gardener. Their grandeur and dignity correspond closely with the magnificence of the Château, and afforded a superb setting for the brilliant court life of Louis XIV.

THE QUEEN'S HOUSE IN THE HAMLET: PETIT TRIANON

In a picturesque group of thatched cottages, built on the banks of an artificial lake, Marie Antoinette, with her friends and children, found pleasure and recreation in watching the simple lives of the rustic households that here carried on real farming as a sort of "performance" for royalty. Sometimes the queen amused herself by making butter and cheese.



© Autochromes Lumière by Gervais Courtellemont

THE BELVEDERE OF THE PETIT TRIANON

On a hill overlooking a lake in the Petit Trianon gardens rises this charming Belvedere. Sculptors and painters vied with each other in decorating it exquisitely for Marie Antoinette. The queen's dairy, in the Hamlet, also had a belvedere called Marlborough's Tower, in allusion to a then popular French song.

THE PARK IN SEPTEMBER

When these stately trees are clothed in glorious colors, the scene from the terrace is compelling in its loveliness. Its tinge of melancholy has inspired poets like Alfred de Musset and Verlaine. Shady walks leading to verdant glades, to groves where fountains play, and distant views of wooded heights, create an unforgettable mind picture.

© Autochromes Lumière by Gervais Courtellemont

THE GROTTO OF APOLLO

The celebrated sculptured group at the entrance to the cave portrays the Sun God, who has come to rest in the dwelling of Tethys, goddess of the sea. Her daughters crowd round to serve him and to offer perfumes. In the hollows of the Grotto, to the right and left, are the horses of Apollo.

THE TEMPLE OF LOVE IN THE GARDENS OF THE PETIT TRIANON

This exquisite cupola supported by a Corinthian colonnade stands on a grassy island and spells Romance. In the center is a replica of Edme Bouchardon's first acclaimed masterpiece of "Cupid Making Himself a Bow Out of the Club of Hercules," the original of which is to be found in the Louvre.

© Autochromes Lumière by Gervais Courtellemont

THE MILL OF MARIE ANTOINETTE: PETIT TRIANON

The Hamlet's simplicity evidences the architectural taste of the period immediately preceding the French Revolution, and is in interesting contrast to the splendors of the Château of Versailles. The queen enjoyed her quiet life here, and little credence can be given to the Hamlet legends which picture the royal family in the rôles of comic-opera shepherds.

XUM

©

Autochrome Lumière by Gervais Courtellemont

THE PARK OF THE PETIT TRIANON IN AUTUMN

A small palace among these trees was the favorite retreat of Marie Antoinette when the restraints of court life and the bondage of etiquette grew too wearisome. She took delight in laying out the park in English style, and its great stands of trees are ever a delight to the forester

Colonnade, designed and built by Mansart. It consists of a circular arrangement of marble columns supporting a balustrade. Between the columns are marble basins, where jets of water played, and in the center of the inclosure is Girardon's group of Pluto and Proserpine.

A story hangs upon this Colonnade. The services of Le Nôtre had been borrowed by Pope Clement X to rearrange the gardens of the Vatican, and in his absence the King had ordered Mansart to build the Colonnade. Upon the great gardener's return, Louis is said to have escorted him to the spot and to have insisted upon hearing the latter's opinion of the new edifice.

Said Le Nôtre, "Why, Sire, what can I say? Of a mason you have made a gardener, and he has given you a sample of his trade."

The Grand Canal, the main body of which is nearly a mile in length, has two arms extending to the right and left and forming a cross. The former is called the Bras de Trianon because at its extremity are situated the Trianons, and the other the Bras de la Ménagerie because at its end in earlier times stood the royal menagerie.

On these waters, in the time of Louis XIV, boating was a popular diversion of the court, and parties made up of the flower of the nobility often spent the night slowly cruising about under the stars, serenaded by music from the shore or from other boats.

The King had his own magnificent galley, which was hung with the richest silks and rigged in crimson and gold, as well as a miniature battleship fully armed. Venice contributed its most luxurious gondolas, with Italian gondoliers to propel them, and these boatmen lived with their families along the canal, where some of their houses still remain and retain their old name of "Little Venice."

LIGHTING EFFECTS ARRANGED BY VIGARANI

Vigarani, who arranged the King's fêtes, also devised illuminations for the gardens and magnificent displays of fireworks on important occasions. The last great lighting of the Grand Canal and the Basin of Apollo was upon the marriage of Marie Antoinette to the Dauphin, grandson of Louis XV, who later succeeded his grandfather and became Louis XVI.

In the gardens before the south wing of the palace stands the Orangery, a great conservatory built by Mansart, and around it the parterre designed by Le Nôtre. This was built because of Louis XIV's fondness for orange trees, which he not only used to adorn his gardens, but also employed in the decoration of the palace itself. Orange trees in his time stood in chased silver tubs around the walls of the Hall of the Mirrors.

THE BUILDING OF THE TRIANONS

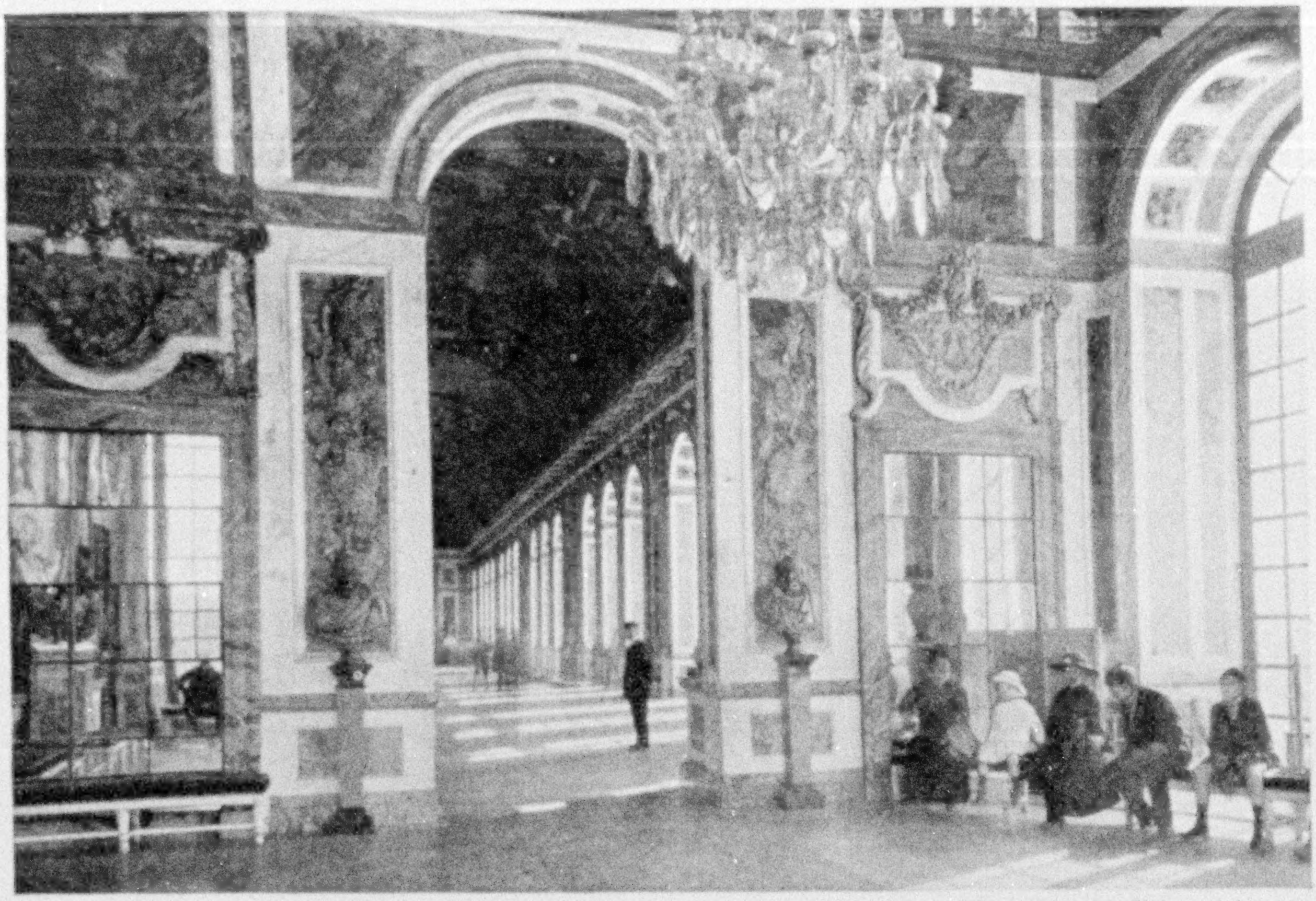
Even before the great palace was completed and the court took up its residence at Versailles, in 1682, the fancy of Madame de Montespan had called for the establishment of a summer house, where fêtes, dancing parties, and suppers could be given. The site chosen was at the end of the right arm of the Grand Canal, where a shabby village called Trianon touched the edge of the park.

The land was taken over, the houses demolished, and the first structure of what is now called the Grand Trianon was built. Later this was rebuilt by Mansart and enlarged.

Madame de Pompadour, Louis XV's most famous mistress, tiring of the attractions of the Grand Trianon, commissioned the architect Gabriel to build a small pavilion near by. In the extended park still another palace was quickly erected, which became known as the Petit Trianon. The interest of the royal family clung to this new palace until the Revolution, and it is perhaps better known than its adjacent predecessor because of its association with the lives of Madame du Barry, who succeeded Madame de Pompadour in the affections of Louis XV, and the ill-fated Marie Antoinette.

Years later the Grand Trianon captivated the fancy of Napoleon Bonaparte, and it was here that he retired for a time after he had his marriage to the Empress Josephine dissolved to permit his grand alliance with Marie Louise of Austria.

Benjamin Franklin, first American en-



Photograph by Clifton Adams

LOOKING INTO THE GALERIE DES GLACES FROM THE SALON DE LA GUERRE

"Kenmore," the historic home of Colonel Fielding Lewis, brother-in-law of George Washington, at Fredericksburg, Virginia, presents an illustration of the far-reaching influence of the decorations at Versailles. In this old house, among the chief things of interest are the ceilings decorated in plaster relief by Hessian prisoners of war from designs by General Washington. They are in the French classic style, and in one room the centerpiece is the conventionalized flaming sun of Louis Quatorze, with nothing less than a portrait of Louis himself in its center.

voy to France, saw Versailles as a private citizen during a visit to Europe in 1767, while Louis XV was still king. Later he visited it officially, when he and his fellow negotiators appeared there in connection with the ratification of the Franco-American alliance signed in 1778.

On his official visit, it is related that he was attired in correct court costume, except that he wore no formal wig, much to the dismay of the attendants charged with the responsibility of enforcing court etiquette down to the minutest detail. A wigmaker had previously endeavored to remedy the omission from his stock of wigs, none of which could be made to fit. "Your wigs are all too small," remarked Dr. Franklin. "Not at all," replied the wigmaker, "Monsieur's head is far too large!"

Marie Antoinette showed special favor to Franklin and enjoyed conversing with him about the new country, in which her interest had been aroused by General Lafayette. The American newspapers of the day rallied him not a little about this intimacy and the *New Hampshire Gazette* printed a story in which he is alleged to have gallantly told her that the little bit of electricity he had stolen from Jove did not compare with that fire she had taken for her eyes.

To tell the whole story of Versailles requires the space of at least one good-sized book, for the place is replete with the interest of art and history in an era of splendor. To the uninformed traveler bored with the sights of Europe, it is outstanding in its magnificence, and to those whose reading has brought even a superficial acquaintance with its wonders, the time spent there is all too short.

CHICHEN ITZÁ, AN ANCIENT AMERICAN MECCA

Recent Excavations in Yucatan Are Bringing to Light the Temples, Palaces, and Pyramids of America's Most Holy Native City

By Sylvanus Griswold Morley

Author of "Excavations at Quirigua, Guatemala," and "The Foremost Intellectual Achievement of Ancient America," in the National Geographic Magazine

ABOUT the time the Western Roman Empire was falling to pieces in the Old World, there took place in the New World an event which was profoundly to affect the history and fortunes of America's most brilliant aboriginal people, namely, the discovery of Yucatan by the Maya, sometime between 471 and 530 A. D.

For perhaps a thousand years prior to this date the Maya had been living in the region now included in the States of Tabasco and Chiapas in Mexico, the Department of Petén in Guatemala, and just along the western frontier of Honduras (see the shaded central zone of the map on page 64).

Here a magnificent civilization had been developed. This region, now overgrown with a dense tropical forest, had been cleared and put under intensive cultivation. Great cities had flourished on every side. Lofty pyramid-temples and splendid palaces of cut stone, spacious plazas and courts filled with elaborately carved monuments of strange yet imposing dignity, market places, terraces, causeways, were to have been counted, not by tens and scores but by hundreds and thousands.

Indeed, it is not improbable that this was one of the most densely populated areas of its size in the world during the first five centuries of the Christian Era, the seat of a mighty American empire.

Nor did other arts and sciences lag behind architecture and sculpture in the Mayan cultural procession. Metal, it is true, the Maya of the Old Empire did not have, but the lack of it did not prevent them from carving such a hard substance as jade, which they made into beautiful pectoral plaques sometimes six inches square, showing their principal deities and rulers in acts of adoration or sacrifice.

Necklaces, anklets, wristlets, earrings, nose-ornaments, beads, and pendants were fashioned from the same refractory material, which, even without the aid of metal tools, seems to have presented little difficulty to the Mayan lapidaries.

THE ANCIENT MAYA WERE GREAT MATHEMATICIANS AND ASTRONOMERS

Exquisite wood carvings, delicate modeling in stucco, ceramics, painting, weaving, and gorgeous mosaics made of brilliantly colored feathers were some of the other arts in which, so far as the native races of the New World are concerned, the Old Empire Maya acknowledged few equals and, with the possible exception of the Inca in the art of weaving, no superiors. And when one comes to a knowledge of the abstract sciences, such as arithmetic, chronology, and astronomy, they had few peers among their contemporaries, even in the Old World.

It would carry us too far astray to explore these fascinating fields of ancient Mayan learning, and it must suffice for the present occasion to point out that their system of keeping account of past time—that is, their chronology—was more accurate than anything known in Europe, Asia, or Africa before the time of Pope Gregory XIII, and it is an open question whether Mayan chronology, in the field of

Drawn by James M. Darley

AN OUTLINE MAP OF CENTRAL AMERICA AND SOUTHERN MEXICO

The region within the circle was that occupied by the Mayan civilization during the first fifteen centuries of the Christian Era. The shaded central portion shows where the Maya lived for upward of a thousand years, before the great Mayan Exodus into the Yucatan Peninsula during the fifth to seventh centuries. This is called the Old Empire, while their subsequent history in Yucatan is known as the New Empire. The arrow shows the location of Chichen Itzá, the great American Mecca.

elapsed time, is not more accurate even than our own Gregorian Calendar.

But the Mayan Dark Ages were approaching. Art, architecture, and learning were soon to suffer a temporary eclipse—one, indeed, from which the first never again fully recovered.

THE MAYAN EXODUS PERHAPS DUE TO THE HIGH COST OF LIVING

The Maya during the seventh century were forced to abandon the Old Empire region, where they had wrought so laboriously and had achieved so splendidly, and to seek new homes elsewhere.

The cause, or perhaps better, causes of this great Mayan Exodus are as yet obscure. Climatic changes rendering the region unfit for further habitation, internecine strife, foreign invasions, intellectual and social exhaustion following hard upon such rapid esthetic development, devastating epidemics of yellow fever, even such a modern manifestation as the High Cost of Living, have been suggested to account for this great historic event.

The writer inclines to this last explanation. The agricultural practices in vogue among the ancient Maya were such as gradually to exhaust the productivity of the land available for cultivation. Planting eventually became impossible, as the repeated burnings which alone served to clear the ground in the absence of tools and work animals, permitted such a thick sod to grow that no cereal could force its way up through it.

The people were literally starved into searching for new homes. No lesser calamity than this, it would seem, could have driven a whole nation to such a drastic step as the complete abandonment of a region wherein they had expended such a tremendous effort.

Whatever may have been responsible for this migration, the fact itself is sufficiently

clear, that Yucatan was discovered as early as the latter half of the fifth century, by advance parties of Old Empire Maya pushing northward toward the then, and even still, unexplored forests of southern Yucatan, looking for a new and more promising land in which to found their homes.

Photograph from the Carnegie Institution

A MODERN MAYA MAIDEN

The descendants of the Indians who built the great cities of Yucatan in the tenth to fifteenth centuries A. D. still live and labor on the henequen plantations of the same region, the men working in the fields, the women at their household tasks. No cleaner people live than the Maya of Yucatan. It is safe to say that every Maya bathes at least once a day. It is said that the old Spanish law gave every man the right to beat his wife if she did not have a tub of hot water ready for his bath when he came in from work. The young girl in the picture, Theresa, is the daughter of the native foreman at Chichen Itzá. She wears the typical dress of the Maya woman, the *huipil*, a sleeveless garment beautifully embroidered in old-fashioned cross-stitch around the neck and the bottom, and a lace-edged underskirt. Slippers, a colored scarf, and a bow of ribbon for the hair complete the costume. Theresa has embroidered the Spanish word for love, "amor," on her huipil.

CHICHEN ITZÁ WAS FOUNDED AS EARLY AS 530 A. D.

Entrance to the new land was from the south and southeast, somewhere in the region of the present Lake Bakhalal, or as it is more familiarly called Bacalar, and, in the words of one of the old native chronicles, it was while they were at Bacalar, a matter of some sixty years, that "Chichen Itzá was learned about," sometime between 471 and 530 A. D

Yucatan must have held not a few disappointments for these early adventuring Americans. It is at best but a parched and waterless land. There is no surface water, and there are no rivers or streams and only one or two lakes. The country is of limestone formation, with only a subterranean water supply and relatively few places where this may be got at naturally. And these first Mayan explorers had neither time nor means for drilling wells.

Here and there about the country a few natural openings or wells have been formed, great holes in the ground, sometimes several hundred feet in diameter, places where the limestone crust has become undermined and has fallen through, exposing subterranean water. These the Maya called *cenotes,* and wherever they existed, there, by very force of circum-

Photograph by J. L. Nusbaum

THIS TEMPLE PRESENTS THE OLDEST DATE PRESERVED AT CHICHEN ITZÁ

This small and comparatively inconspicuous temple is one of the most important buildings at Chichen Itzá, from a scientific point of view, since the lintel over its front doorway presents the earliest date yet found in the city. The doorway where this lintel was found does not appear to be the one for which it was originally designed, since the two supporting columns, carved in the likeness of human figures with arms upraised, are so placed that they hide part of the inscription on the under surface of the lintel. It seems probable, therefore, that this slab was originally made to fit a narrower doorway.

stance, important centers of population were established and flourished.

The place where Chichen Itzá was later to be founded was peculiarly favored in this respect, for here the waterless plain of Yucatan is pierced by two of these great natural wells within half a mile of each other. Under primitive conditions, this fact alone determined that an important city would one day grow up around them.

The very name Chichen Itzá has memorialized this fact for all time. *"Chi"* in Maya means mouths, and *"chen"* wells, and Itzá was the name of the particular Mayan tribe or group which had first wandered this way—"The Mouths of the Wells of the Itzá"—a proud and distinctive name, which at once emphasized Itzán importance in the new land as compared with the less fortunate lot of their more "dry" brethren.

Although there is some confusion as to the exact date, the city seems to have been founded not later than 530 A. D.; and here again the "Holy Men of the Itzá," as they are almost worshipfully called in the native chronicles, the Books of Chilan Balam, set up their tribal deities, their Lares and Penates.

CHICHEN ITZÁ AT FIRST UNIMPORTANT IN THE MAYAN WORLD

During the first century of its history, one should not forget that, as cities went in the Mayan world of that day, the new settlement was of little consequence. To a Maya of the late sixth century living in Copan, Tikal, Palenque, or any one of a dozen other cities of the Old Empire, if he gave this little frontier town a thought at all—if, indeed, he had as much as heard of it—he would have dismissed it with precisely the same consideration that the average New Yorker or Bostonian would dismiss the claims of Gallup, New Mexico,

or Deadwood, South Dakota, to metropolitan consideration.

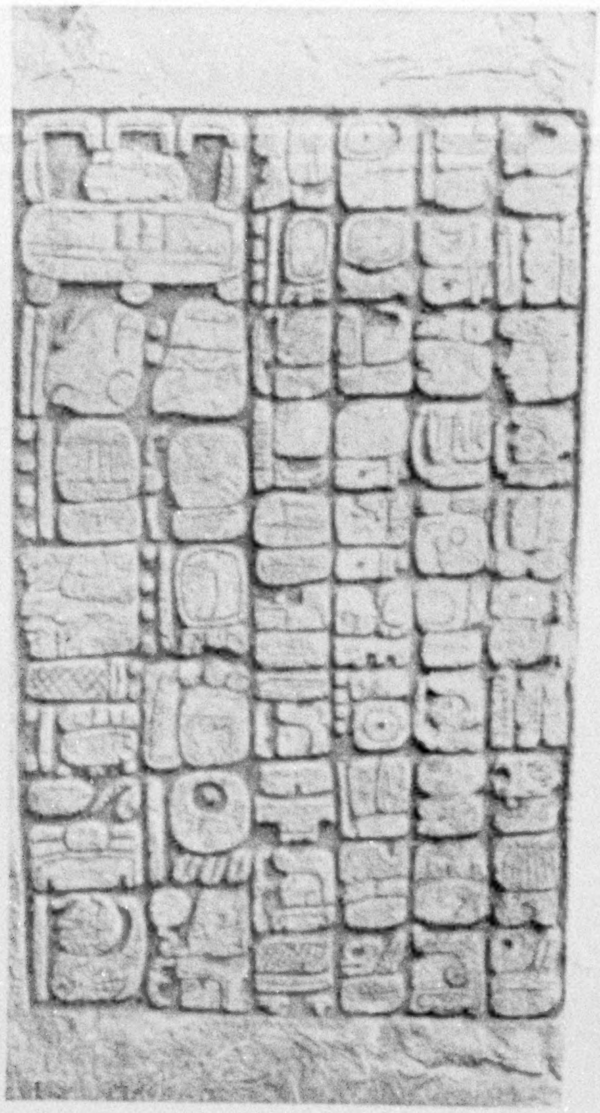
Living in the shadow of the great temples of Copan, let us say, surrounded by all the manifestations of the highest native civilization this continent brought forth, secure in the protection of his gods, rulers, and priests, a Maya of the sixth century might well be pardoned for having looked askance at those more venturesome spirits among his people who, leaving peace and security behind, were pushing outward into such a vast and limitless unknown as the wilderness of Yucatan must have been at that time. He probably would have said: "Let well enough alone. True our fields are no longer as fertile as they used to be, and our crops grow scantier year by year; but even so, why change the surety, the confidence and comforts of life here for the known hardships and unknown terrors of those distant wilds?" Why indeed?

But "mighty oaks from little acorns grow," and the new settlement, founded so inconspicuously as to have caused scarcely a ripple in the Mayan world of that remote day, was destined to outlive them all. In the late New Empire five centuries and more after the cities of the Old Empire had been abandoned and lay in desolation, buried beneath a vast tropical forest, their palaces and temples become the haunt of jaguar and monkey, Chichen Itzá had grown to be the largest city of her day—indeed, more—the holiest city of her times, the Mecca of the Mayan World.

But we are ahead of our story.

THE OLDEST PART OF THE CITY

The city's early struggles must have been acute. It was far removed from other centers of population, and notwithstanding its inexhaustible water supply, it is to be doubted whether the new colony prospered greatly. Only one monument has been found at Chichen Itzá which may surely be ascribed to this first period of its occupation. It is a stone door lintel, which was dedicated on August 28, 619 A. D. It presents no carvings other than its hieroglyphic inscription, but fortunately this is well enough preserved to permit the exact decipherment of its dedicatory date as given on this page.



Photograph by Edward H. Thompson

THE EARLIEST DATED HIEROGLYPHIC INSCRIPTION AT CHICHEN ITZÁ

This inscription is carved upon the front and under side of the principal doorway of the temple shown on the opposite page. The dedicatory date was 10.2.10.0.0 2 Ahau 13 Chen of the Mayan Era, corresponding to August 28, 619, A. D., and is presented on the front of the lintel. The inscription on the under side, shown here, begins with a date 331 days earlier than the dedicatory date, corresponding to October 2, 618 A. D. This latter date (10.2.9.1.9) is expressed by the familiar "bar and dot" numerals already explained in a former issue of the NATIONAL GEOGRAPHIC MAGAZINE (February, 1922), wherein the bar equals 5 and the dot 1, written in the first two columns to the left.

This lintel was found over the doorway of a small temple in the southern part of the city and its early date, the earliest yet found anywhere at Chichen Itzá, coupled with the fact that the other buildings of this section are in a more advanced state of ruin than elsewhere, suggests that this may be the oldest part of the city.

CHICHEN ITZÁ ABANDONED

In 668 A. D. the city was abandoned for some unknown reason, and the Itzá,

Photograph from the Carnegie Institution

THE CASTILLO, OR GREAT TEMPLE OF KUKULCAN, PATRON DEITY OF CHICHEN ITZÁ

This majestic pyramid, surmounted by an imposing temple, rises in nine receding terraces to a height of 100 feet above the plain and covers an acre of ground. It is approached by four stairways, one on each side, the one ascending the northern face, or front, being flanked by enormous balustrades carved in the likeness of the Feathered Serpent, patron deity of the city, the head resting on the ground at the foot of the stairway, the tail rearing itself aloft on top. The temple proper contains three chambers: an antechamber, or outer corridor, a back corridor extending around on both sides, and the inner sanctuary, the most holy place in the city. It was here that the ceremonies began—the incensing of the sacrificial victims, which terminated so tragically at the brink of the Cenote of Sacrifice, a quarter of a mile distant, at the other end of the Via Sacra (see page 80).

again on the trek, moved westward across the peninsula of Yucatan and founded a new capital, called Chakanputun, in the region south of the modern Campeche, where they dwelt for more than two centuries.

This first abandonment of Chichen Itzá was roughly contemporaneous with the final abandonment of the last surviving cities of the Old Empire—Tikal, Xultun, Uaxactun, Nakum, and others in the northeastern corner of Guatemala—and it may possibly have been due to the same cause, whatever that was, perhaps as already suggested, to the High Cost of Living.

THE CITY REOCCUPIED

The destruction of Chakanputun by fire in 944 A. D. again set the "Holy Men of the Itzá" wandering, and, perhaps mindful of those two cool and refreshing cenotes at the "Mouths of the Wells of the Itzá," like homing pigeons, they turned their steps thither and reoccupied the site in 964 A. D.

Photograph by S. Badia

ANTECHAMBER OF THE GREAT TEMPLE OF KUKULCAN

The principal doorway of the temple is flanked by a pair of massive stone columns carved to represent feathered serpents. Looking out through these, one commands a magnificent view of the northern part of the city. To the northeast lies the Group of the Thousand Columns, with its many colonnaded halls, pyramids, temples, courts, and plazas. In front stretches the Via Sacra, leading straight as an arrow from the broad terrace in front of the Castillo to the edge of the Cenote of Sacrifice, a quarter of a mile away (see page 84). To the northwest rise the twin walls of the Great Ball Court, or Tlachtli field, the Temple of the Tigers surmounting the southern end of the eastern wall.

But now the horizon of Mayan history broadens. Other tribes, moving out of the Old Empire region into Yucatan, have founded other cities. The Tutul Xiu have established themselves at Uxmal, destined to become the second city in size in the peninsula. The Cocom, a kindred tribe, have built their capital at Mayapan, "The Standard of the Maya" in the northwest, near Uxmal. Many other smaller cities have grown up; at last the New Empire is fairly under way, the second and last phase of the colorful Maya story.

THE LEAGUE OF MAYAPAN, THE MAYAN RENAISSANCE

In 1004 A. D. the three largest city-states—Chichen Itzá, Uxmal, and Mayapan—formed a triple alliance, under the name of the League of Mayapan, by which the government of the peninsula was divided equally among them.

This is the period of the true Mayan Renaissance. Under the peaceful conditions and general prosperity brought about by the league, art and architecture revived. Great buildings of cut stone, elaborately decorated with sculptures, were put up on every side. No town or village was so small and unimportant as not to boast its pyramid-temple and chief's house built of stone. It was in every sense a true Renaissance, and under its quickening influence the Mayan esthetic instinct blossomed forth anew.

Chichen Itzá does not seem to have felt this stimulation as strongly as her sister state, Uxmal, for example, although there are a number of buildings at the Itzán capital which date from this pe-

Photograph from the Carnegie Institution

THE STONE RING OF THE TLACHTLI FIELD (SEE ALSO OPPOSITE PAGE)

This great stone ring was formerly fastened to the western wall of the Tlachtli court, opposite the ring shown on page 71. It is 4 feet in diameter, 11 inches in thickness, and the diameter of the hole is 18 inches. Both of these rings are decorated on both sides with pairs of intertwining feathered serpents, which are always portrayed at Chichen Itzá as rattlesnakes.

riod—the Akab'tzib (House of the Dark Writing), the Chichanchob (Red House), the House of the Deer, and parts of the Monjas (Monastery)—in fact, most of the middle section of the city, that part lying south and west of the Group of the Thousand Columns.

But not yet had Chichen Itzá reached her greatest development, her crowning glory as the Holy City of the Maya. This was not to come until another turn in the wheel of fate had brought her under the heel of a foreign conqueror and the Itzán people had been made to feel the gall and bitterness of foreign rulers and a foreign religion.

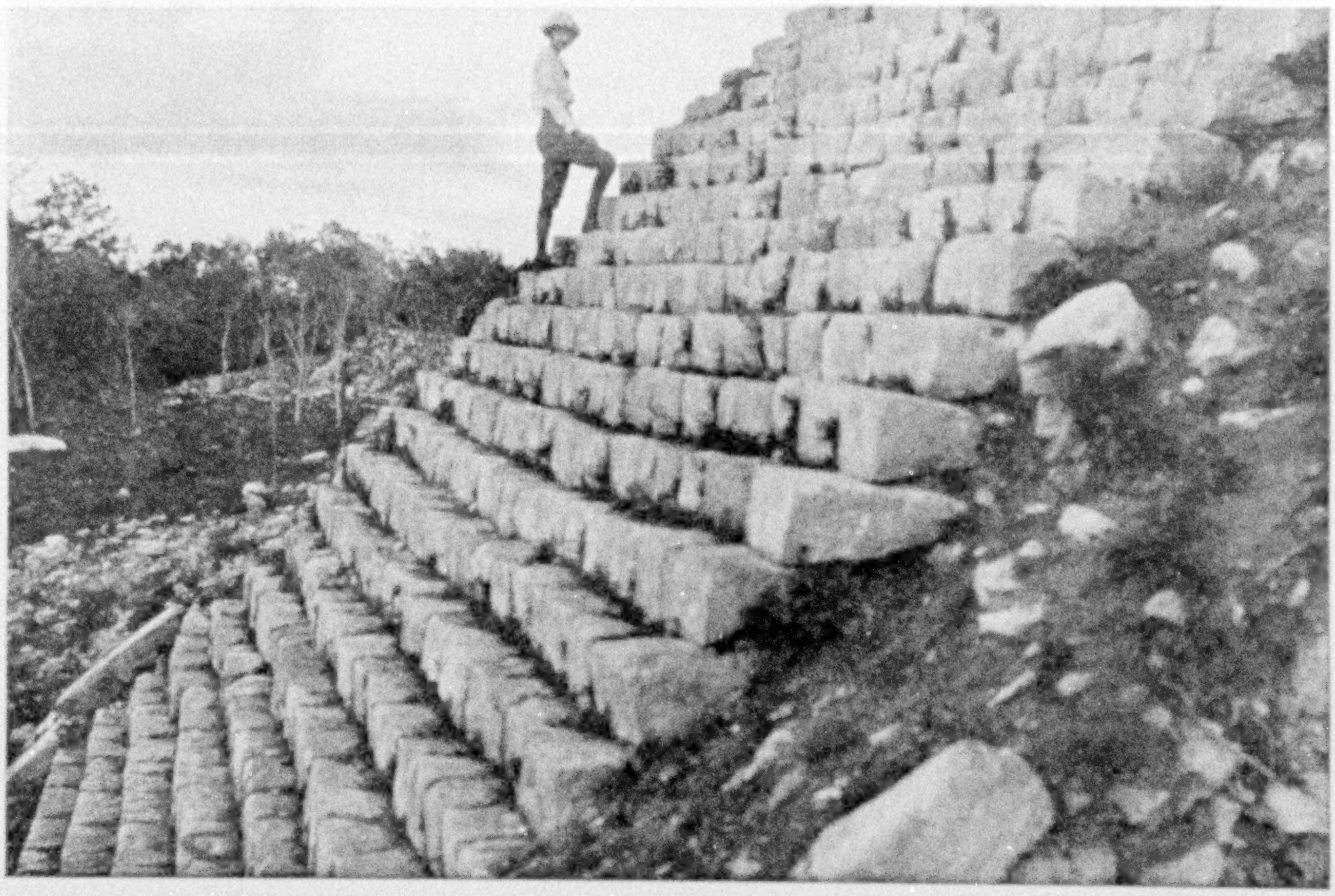
In 1201 A. D. the political structure of the peninsula was shaken to its foundations and the League of Mayapan violently disrupted by war within itself. In that year Hunnac Ceel, the ruler of Mayapan, made war upon Chac Xib Chac (the Very Red Man), the Itzán ruler, because of "certain banquetings with the ruler of Izamal," according to one of the chronicles (we should, perhaps, read here conspiracies), and by the aid of Toltec-Aztec allies from central Mexico inflicted a crushing defeat upon the Holy Men of the Itzá.

The chronicles do not enlighten us further as to what end overtook the "Very

Photograph by J. L. Nusbaum

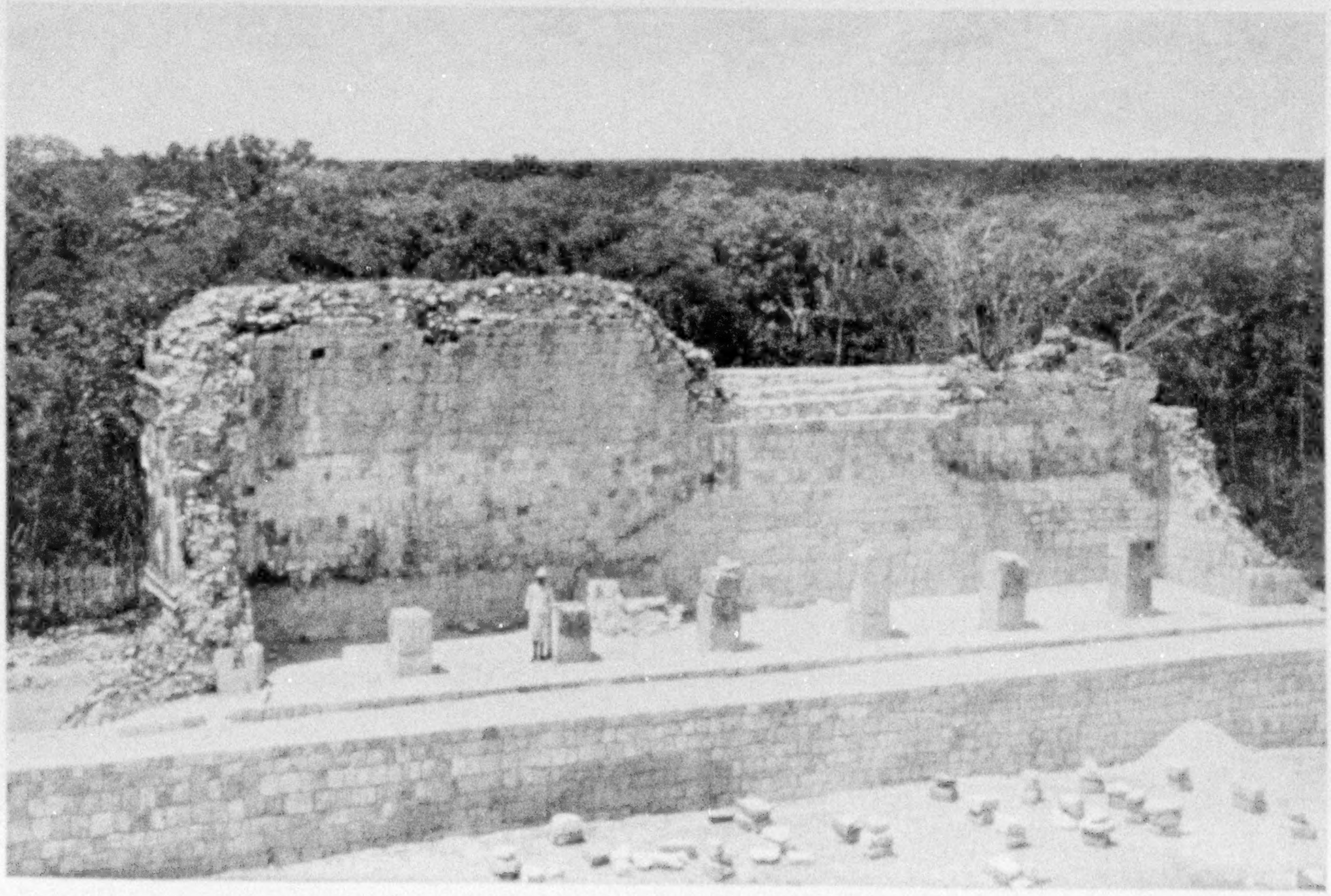
THE GREAT BALL COURT, OR "TLACHTLI" FIELD

The Tlachtli field, where a game not unlike the modern game of basket-ball was played, is composed of two massive parallel stone walls 119 feet apart, 28 feet high, 39 feet thick at the base, and 272 feet long. At each open end stands a temple (see pages 72-73), and the whole area is as large as a modern football field. In the middle of each wall, 24 feet above the level of the court and directly opposite each other, is a stone ring. The object of the game was to drive a solid rubber ball through this hole, a difficult feat, since the player had to stand close to the wall when he attempted this, otherwise he could not get it through the hole.



STAIRWAY ASCENDING THE WESTERN FACE OF THE CASTILLO

This stairway is 37 feet broad, including its two plain balustrades, and is exceedingly steep, rising at an angle of 45 degrees. There are 103 steps to the summit (see also page 68).



Photographs from the Carnegie Institution

THE SOUTH TEMPLE OF THE TLACHTLI FIELD

This building is 80 feet long and 16 feet wide and was little more than an open portico supported by six square columns. It stands at the southern end of the Tlachtli court, the long, high side walls of which make acoustic properties which are little short of amazing—an ancient whispering gallery.

Photograph from the Carnegie Institution

THE NORTH TEMPLE OF THE TLACHTLI FIELD

This structure is composed of a single chamber, the front supported by two round columns, which, with the three interior walls, are entirely covered with elaborate sculptures portraying lines of marching warriors. The upper part of the back wall slopes forward and acts as a sounding-board, throwing out across the court sounds made in front of it at a position between the two columns. The Tlachtli court constitutes a splendid open-air auditorium capable of accommodating 5,000 people, and upon the occasion of the opening of the state highway from Dzitas, the nearest railroad point to Chichen Itzá, in 1923, beautiful native dances in costume were staged here.

Red Man." Perhaps he fell fighting bravely, as his name might imply, in the defense of his capital. Concerning the fate of the city itself, however, archeology leaves us in little doubt. From this time onward until its final abandonment, in 1448, Chichen Itzá was held in thrall by foreign rulers, the Toltec-Aztec allies of Hunnac Ceel.

This foreign influence from the distant Vale of Anahuac gave to the city not only new rulers, but also new customs, new esthetic inspirations, a new architecture, even a new religion, all of which reacted powerfully upon the Itzá people and raised their capital to a position of honor and sanctity never enjoyed by it or any other Mayan city before or since.

Photograph by Gomez Rul

THE CARACOL, OR ASTRONOMICAL OBSERVATORY

This round tower, rising 75 feet above the plain, is 37 feet in diameter at the base and surmounts a double terrace reached by stairways on the western side. Perhaps the most conspicuous architectural feature is the 5-member cornice running around the top of the lower section. No other building in the whole Mayan area has such a cornice, the usual number being limited to three. There are four doorways facing the four cardinal points, which give access to an outer corridor. Four other doorways pierce the inside wall of this corridor, giving entrance to the inner corridor. These two corridors are circular, running clear around the tower. The center is occupied by a solid core of masonry, in the heart of which is a spiral stairway leading to a small chamber in the upper part. The fancied resemblance of the turning of this stairway to a snail shell has given the name by which the building is now known locally, caracol, meaning snail in Spanish.

This small upper chamber is now almost entirely demolished, but leading off from it, looking due west, is a small stone-lined passage, or line of sight, used for taking astronomical observations upon heavenly bodies at the moment of their setting—the sun, moon, and planets. It is probable that formerly there was a similar line of sight to the east for making sunrise observations, but this has now disappeared with the collapse of the entire eastern side of the tower.

In 1923 Dr. Morley excavated a hieroglyphic monument from a niche between the two stairways ascending the upper terrace, which has 132 hieroglyphics engraved upon it, the longest inscription yet found anywhere in the city.

The conquerors brought with them the worship of the fair golden-haired god, Quetzalcoatl, the "Feathered Serpent." Removed to Chichen Itzá, this Toltec Zeus became Kukulcan, a direct Mayan translation of Quetzalcoatl; and presently

Photograph from the Carnegie Institution

ENTRANCE TO THE TEMPLE OF THE JAGUARS

This structure surmounts the southern end of the eastern wall of the Tlachtli court. It is guarded by two immense feathered-serpent columns, the heads of which, breast high, show here. Note the great round poison fangs in the nearer head, the feathered lips, the curl at the back of the mouth. The hollow, deep-set eyes were formerly filled with an inlay of some sort—shell, obsidian, or colored stones.

all over the northern part of the city, which dates principally from this last period, temples and sanctuaries were rising to the new god, all adorned with highly realistic representations of the Feathered Serpent—in columns, balustrades, cornices, and bas-reliefs—until his sinuous trail was to be seen on every side.

Never before had the city experienced such a building boom. The so-called Castillo, which in fact is not a castle at all, but the principal temple of Kukulcan at Chichen Itzá, dates from this period. It covers an acre of ground and towers more than 100 feet above the level of the broad plaza at its base, overtopping the highest trees. Four balustraded stairways ascend its terraced sides, and the sanctuary on the summit is entered through a doorway flanked by feathered serpent columns (see pp. 68, 69, and 72).

Another enormous construction of the Toltec-Aztec period at Chichen Itzá is the Group of the Thousand Columns, a vast architectural complex inclosing a central plaza containing more than five acres, and composed of pyramid-temples, colonnaded halls, sunken courts, terraces and platforms; and here, too, everywhere may be seen the trail of Kukulcan, the

Photograph by S. Badia

THE COURT OF THE THOUSAND COLUMNS, LOOKING SOUTHWEST FROM THE NORTHEAST INTERIOR CORNER

This great court, enclosing an area of five acres, is the center of the Group of the Thousand Columns, that part of the city now being excavated. The name has been derived from the commonest architectural feature of the group, the round column. More than a thousand of these have been counted in the different temples, halls, and colonnades surrounding the court. These columns, composed of drum-like sections, averaging just under 2 feet in diameter, are from 8 to 10 feet in height. A few of the halls have square columns instead of round ones; these also are made in sections. Most of the columns are plain, though a few are sculptured with the figures of gods, rulers, and priests. This group dates from the Toltec-Aztec Period at Chichen Itzá and is between five and eight centuries old.

Photograph from the Carnegie Institution

THE TEMPLE OF THE TABLES

Six tables, or altars, supported by small human figures, were found against the back wall of this sanctuary when it was excavated. The picture shows one of these altars still in its original position on the summit at the right. The whole back wall has fallen, leaving the four square columns of the sanctuary exposed. The other five altars are fallen, though the statuettes which originally supported them are scattered about in the immediate vicinity.

XUM

Photograph from the Carnegie Institution

STAIRWAY LEADING TO THE EAST WALL OF THE TLACHTLI FIELD

The backs of the two side walls of the Tlachtli court originally were provided with wide stairways ascending to their summits, which afforded a splendid view of the game being played below. The balustrades of these stairways are again representations of the feathered rattlesnake. In the stairway shown above, the rattles are at the bottom of the balustrade and the head, now missing, was at the top. These rattles appear to the left and two steps below the standing figure.

Feathered Serpent, patron deity of the city.

Other buildings of the period are the Tlachtli-ground or Ball Court and the Temple of the Jaguars, the Caracol or Astronomical Observatory, the Temple of the Tables, the High Priest's Grave, the Northwest Group, etc.

In two and a half centuries, 1201-1448 A. D., more buildings went up in the city than had been built since its foundation, six centuries earlier.

The foreign rulers, with their new ideas, their new customs, their new religion, gave to the Itzá just that impetus, just that spur to do, which had been lacking at the end of the twelfth century, almost to the point of stagnation. Under their progressive and vigorous rule, the Itzá came back strongly once again before final eclipse overtook them in the middle of the fifteenth century.

SANCTITY OF THE CITY ASSOCIATED WITH ITS NATURAL WELLS

But nothing has been said as yet regarding the sacred character of Chichen Itzá during this final period, her crowning distinction as the Holy City of the Maya, our justification for calling her an ancient American Mecca.

This claim to special sanctity is so intimately connected with the two cenotes, which had been chiefly, if not solely, responsible for the location of a settlement here in the beginning (see text, page 66), that a description of them may not be out of place.

From the beginning, it is probable that the southern cenote, that known locally as Xtoloc, or "iguana" in Maya, had been used as the chief source of the water supply. It is nearer the center of the city and its sides are less precipitous than those of the northern cenote, so that a masonry stairway could be built down one side leading to the water's edge, 70 feet below the level of the ground.

FEATHERED-SERPENT STAIRWAY LEADING TO THE HIGH PRIEST'S GRAVE

Photographs from the Carnegie Institution

ENTRANCE TO THE BURIAL SHAFT IN THE HIGH PRIEST'S GRAVE

In the floor of the sanctuary of the High Priest's Grave, some 15 feet behind the column shown on page 86, is the above opening. This is the entrance to a stone-lined burial shaft which passes down through the center of the pyramid supporting the temple, to the level of the ground, 37 feet below. At the bottom of this shaft six stone steps lead downward into a small natural hollow in the solid limestone, and in the floor of the latter there is a hole giving into a cavern, the floor of which is still 40 feet lower.

Photograph from the Carnegie Institution

THE SANCTUARY OF THE TEMPLE OF THE TABLES

The ceiling of the sanctuary was supported by four square columns, all sides of which were covered with elaborate sculptures representing gods, rulers, priests, or warriors. In the foreground stand seven of the statuettes which formerly supported the altars across the back wall. The doorway in the center leads to the antechamber of the temple, the ceiling of which was similarly supported by four square sculptured columns. The fretlike ornament leaning against the back wall, between the first and second columns on the left, and the similar ornament just to the right of the doorway originally stood around the edges of the top of the roof, much like the iron fencing around the mansard roofs of fifty years ago. The long tail-like appendages are the tenons by which they were fastened to the roof.

The other cenote is somewhat larger, being 180 feet in diameter, with vertical or even undercut sides; so that it is to be doubted whether it ever served as a source for water, and may from the first, because of its comparative inaccessibility, have been held in some veneration, if not, indeed, in actual awe (see page 84).

ITZÁN MAIDENS SACRIFICED TO THE GODS

The Toltec-Aztec conquerors, however, appear to have been the first to capitalize successfully the semi-sacred character which it had acquired in the passing centuries. This was done by inaugurating at its brink a gruesome sacrificial rite, which was destined to attract pilgrims thither from all parts of the Mayan world; no less, indeed, than hurling into its gloomy depths the young Itzán maidens to appease the wrath of offended deities.

Along with these human sacrifices all sorts of valuable personal objects were thrown into the pool, which until the present day bears the name of Cenote of Sacrifice. Gold and jade ornaments, beautiful pieces of pottery, carved wood, in fact, everything of highest value found its way thither, there to lie for five centuries or more, until rescued from oblivion by the dredge of an archeologist.

SPECTACULAR SACRIFICE ATTRACTED THOUSANDS

The very spectacularity of this cruel rite—the maidens at the brink of the dark pool, the incensing of the priests, the sides lined with waiting thousands, a push, perchance a startled cry, a splash below, and silence—all combined to arouse a general interest in the ceremony. Pilgrims came from far and near to hurl their personal treasures into the depths.

Photograph by Gomez Rul

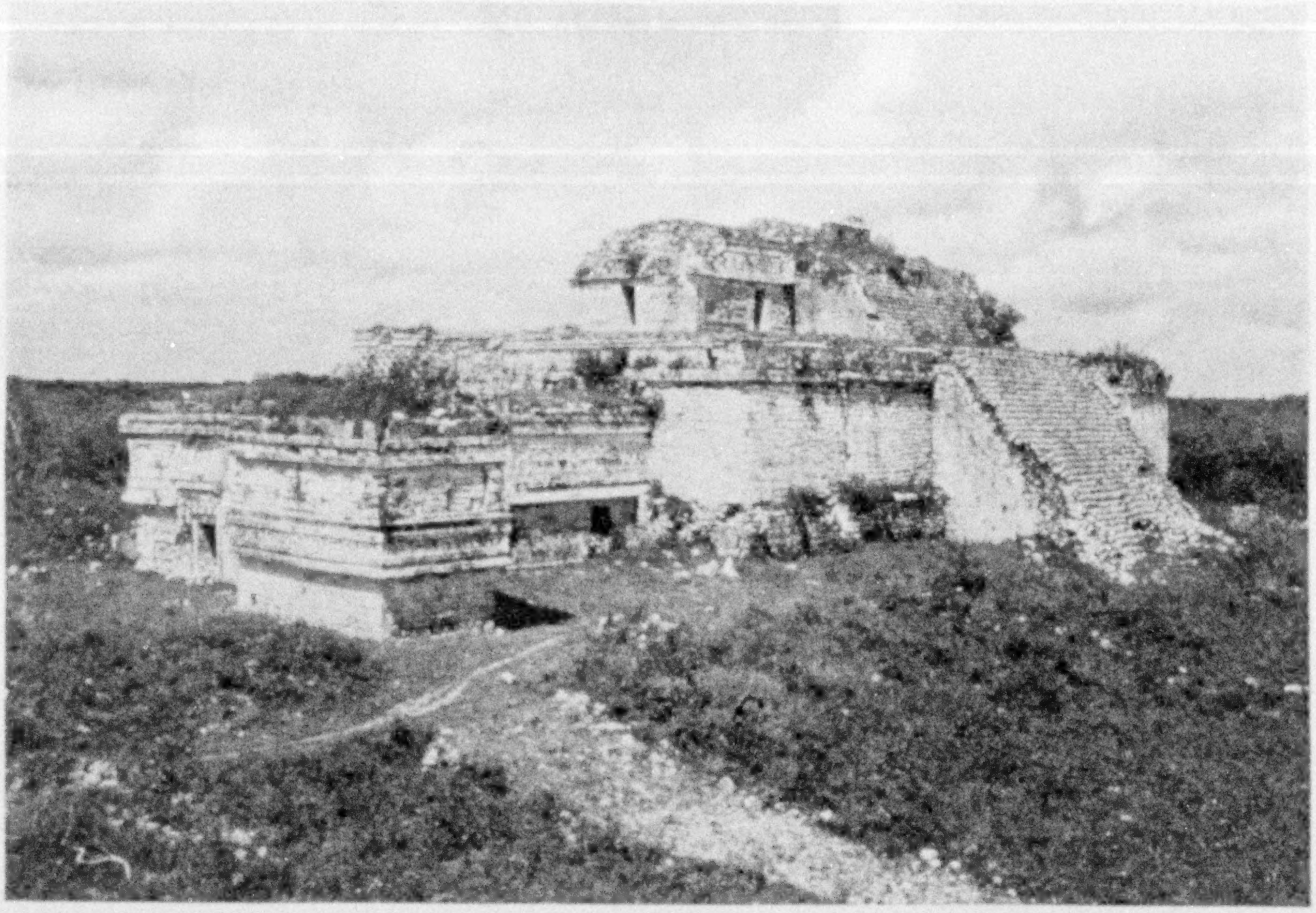
STONE ALTAR SUPPORTED BY FOUR STATUETTES

One of the stone altars in the sanctuary of the Temple of the Tables is shown at the right. These altars average 4 feet in length by 2½ feet in width and stand 3 feet high. More than a hundred of the statuettes which were originally used to support them have already been found at Chichen Itzá. In the lower left corner appears the face of one of these statuettes, which may have been dedicated to the four Bacabs, a class of Mayan deities presiding over the four cardinal points.

Pendants and bells of gold have been found here which are known to have been made no nearer than Costa Rica, and pottery of a peculiar type, not unlike cloisonné ware, which could only have come from northwestern Mexico. Such was the fame and appeal of this death by water.

The rulers of the city on their part had spared no efforts to give the ceremony a proper setting. The great Temple of Kukulcan had been located with special reference to this pool of sacrifice—that is, facing it—and connected with it by a stone causeway or *Via Sacra*, a quarter of a mile long, 30 feet broad, and in places built up 25 feet above the level of the plain. Other temples had been erected in the immediate vicinity, including two elaborately decorated dancing platforms, and at the edge of the cenote itself there was a small shrine for the last solemn rites.

The somber natural beauty of this deep pool, with its chalky white sides covered with clinging vines of green, the imposing temples, and other buildings associated with it, the long procession of gorgeously



THE MONJAS, PROBABLY THE PALACE OF THE ITZÁN RULERS

This magnificent edifice, with its several annexes, is 300 feet long, 150 feet wide, and it must have been fully 70 feet high. At least eight different periods of construction or modifications of the original building by later additions have been detected, and many of the sculptured stones used in its decoration, practically everywhere except in the second story, belonged to earlier structures now destroyed. The writer uses the chamber in the eastern end of the second story, shown at the left, as his office and bedroom.

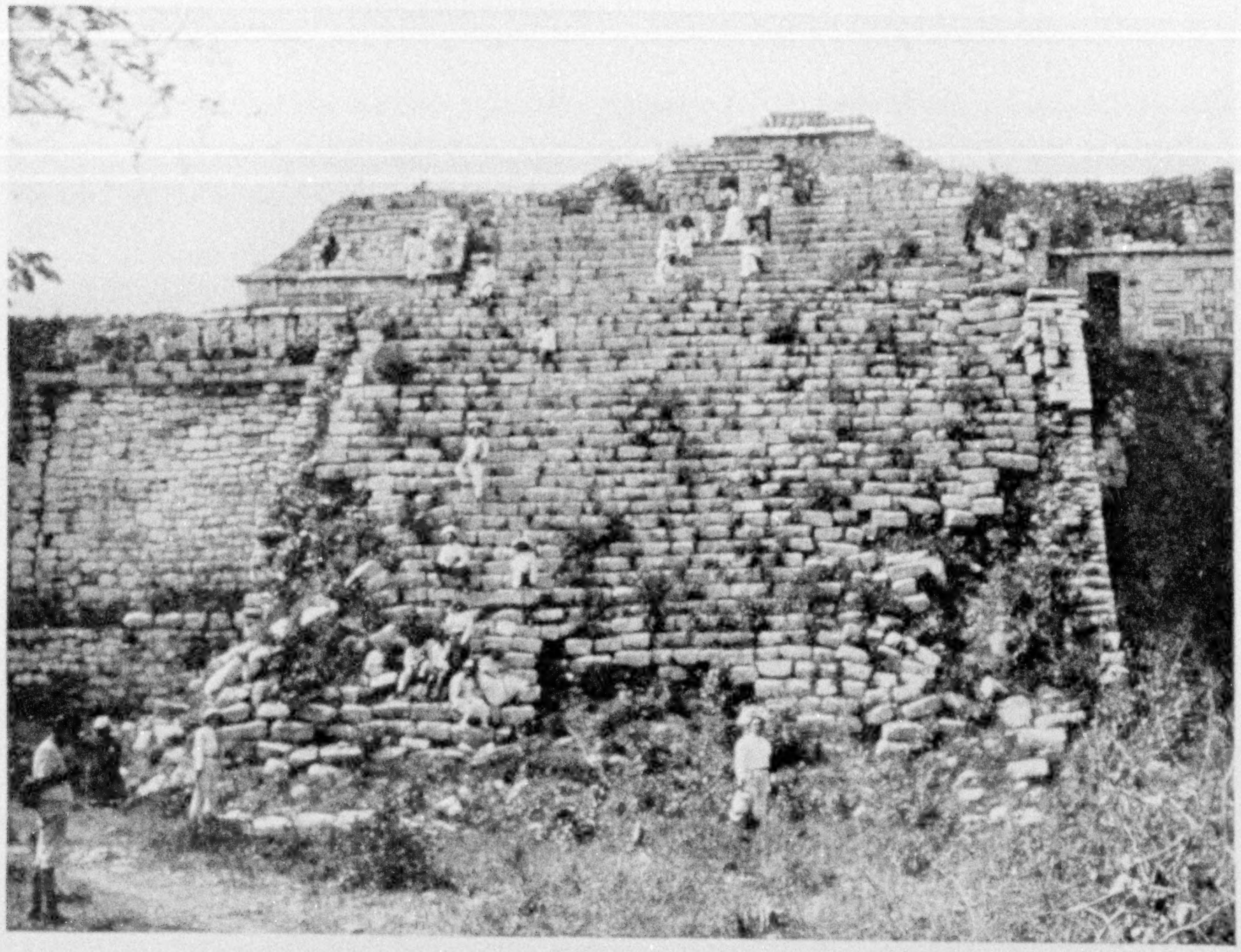
robed priests leading their victims to the brink, the spectacular sacrifice itself—a dramatic hurtling through the air into the dark, silent water below—all combined to affect powerfully the aboriginal mind. Thousands were attracted thither, until by the early fifteenth century Chichen Itzá had become, because of this great ceremony, the most holy city in the New Empire — nay more, the Mecca of the Mayan World.

CARNEGIE INSTITUTION BEGINS TEN YEARS OF EXCAVATION AT THIS SITE

For a decade now the Carnegie Institution of Washington has had under consideration a plan for the intensive study of this ancient American metropolis. Several preliminary expeditions had been sent to the site to ascertain the precise nature of the practical as well as the archeological problems involved, and in June, 1923, a formal plan of study covering a period of not less than 10 years was presented to the Mexican Government.

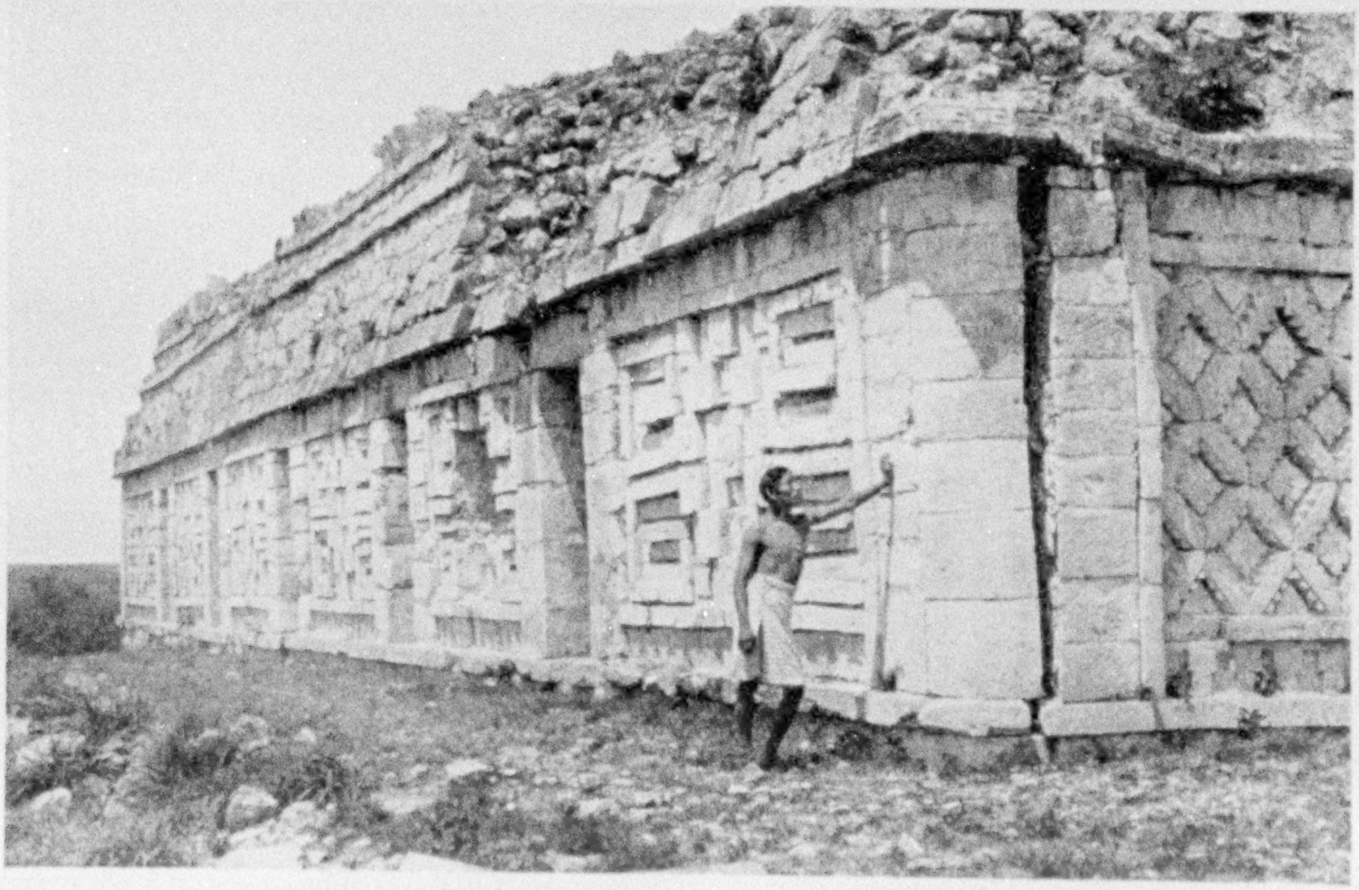
This plan having been approved by the Dirección de Antropologia, which has jurisdiction over all archeological remains in the Republic of Mexico, an agreement was reached under the terms of which the Carnegie Institution was granted the privilege of carrying on archeological investigations at Chichen Itzá for a period of 10 years, beginning January 1, 1924.

Before actual excavations could be undertaken, however, it was essential that an accurate survey be made of the city and a base map prepared, to which all subsequent discoveries could be referred, and during the late winter and early spring of last year, through the courtesy of the United States Geological Survey, one of its engineers, Mr. J. O. Kilmartin, made such a map on a scale of 1 to 200, locating thereupon all the artificial constructions within the area surveyed, nearly



Photograph by Gomez Rul

STAIRWAY LEADING TO THE SECOND STORY OF THE MONJAS



Photograph from the Carnegie Institution

THE BACK OF THE SECOND STORY OF THE MONJAS

An especially pleasing feature of the second story of the Monjas is the sloping upper half of the façade, a very unusual treatment in the New Empire. This feature reached its highest development in the Old Empire at Palenque.

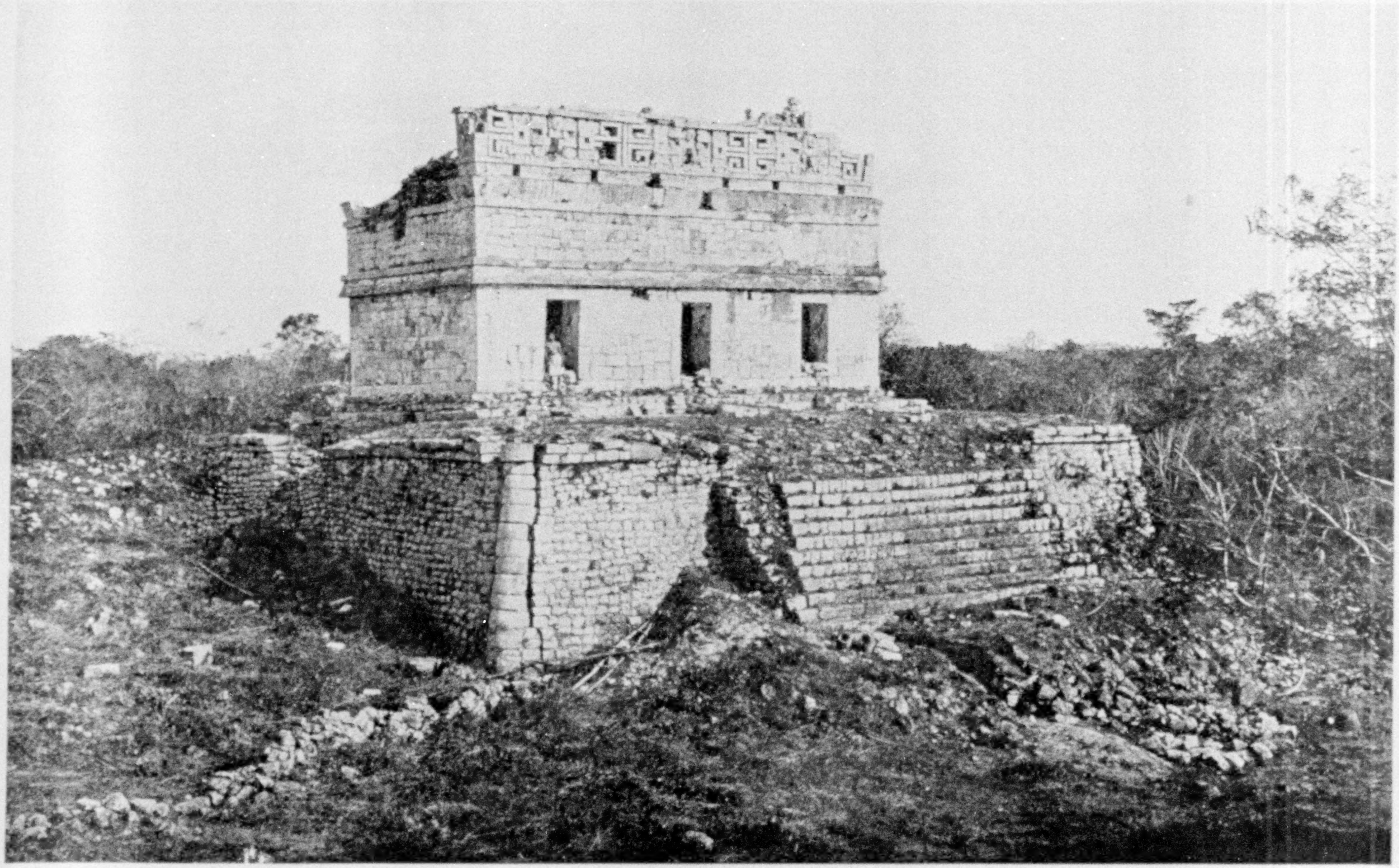
XUM

Photograph from the Carnegie Institution

THE CENOTE OF SACRIFICE

This natural well or hole in the limestone surface is 180 feet in diameter and 70 feet in depth, to the water's edge. The water in this great pocket is another 70 feet deep and remains at the same level practically the year around. This view is taken from a point directly opposite the end of the Via Sacra, which runs from the terrace in front of the Castillo (see page 68) to the sacred well. The small mound on the far bank, where several figures are standing, appears to have been a shrine in which offerings were made and incense was burned. The spot from which the Itzán maidens were hurled to the depths below, together with the Itzán treasure of gold and jade and their most cherished possessions, may be seen just to the left and a little below the standing figure in white, the masonry of the platform showing below the bank.

Fringed with walls of living green, this somber pool lies sinister and silent at one's feet, its solitude broken only by the cooing dove, the melody of the humming bird, and the music of many songsters, which have nested in the rocky ledges of its perpendicular sides. Standing on this hallowed ground, one pictures those fearsome ceremonies, which culminated here so tragically—the long procession winding down the Sacred Way, fanatical priests leading their garlanded victims amid clouds of incense, the waiting thousands gathered round the edges. One sees again that awful rite: a maiden standing at the brink, a leap, a startled cry, a hurtling swiftly through the air to death below, followed by a shower of jades and jewels, the offerings of the pious.



Photograph from the Carnegie Institution

THE RED HOUSE

This building derives its name from a red band running around the antechamber, to which the three doorways shown in this picture give access. Three doorways in the back wall of the antechamber and opposite to the three exterior doorways give entrance to three small sanctuaries of equal size at the back, a most unusual type of ground plan for Mayan temples. Across the back wall of the antechamber, just above the spring of the arch, there is a band of hieroglyphics, 37 feet in length; but unfortunately these have successfully defied all efforts leading to their decipherment up to the present time. The Red House is said to be the best preserved example of Mayan architecture extant.

XUM

Photograph from the Carnegie Institution

PAST AND PRESENT

Two hundred thousand Maya toil for foreign masters to-day in the henequen fields of Yucatan, all memory of their former magnificence gone as completely as if it had never been. Their wants are few and easily filled: simple food—tortillas, black beans, squash, chile—and tobacco; cotton stuff to make the shirts and pantaloons for himself and his son and for the huipils of his wife and daughter; anisette by way of a celebration on feast days, and he is as happy as he can be under masters not wholly of his own blood. But, with such a glorious past, it would seem as though his future might be made of even greater promise than this. With proper educational facilities, with fair agricultural opportunities, with intelligent help over the rough places in the road, he must travel from his own simple past to the complicated world of to-day, and there is every reason to expect that he may again fashion for himself a destiny worthy of his splendid ancestry.

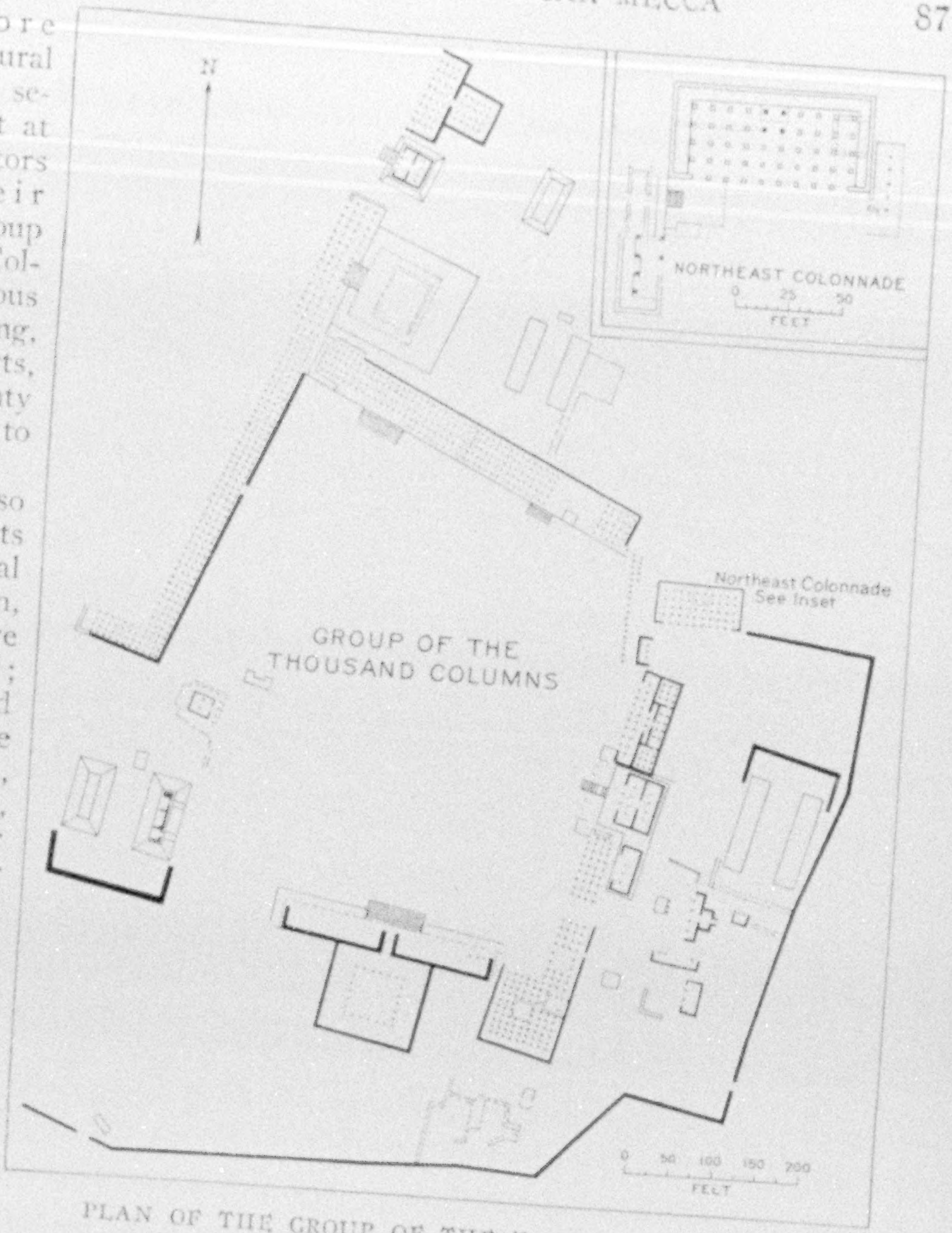
a mile square. The other members of the staff, including the writer, in charge of the Chichen Itzá Project, Mr. E. H. Morris, archeologist in charge of excavations, and Mr. Monroe Amsden, assistant archeologist, reached Chichen Itzá the middle of May and excavations were commenced on May 28.

In the case of such a large archeological site as this, any excavation program that was not strongly concentrated, and specialized in its direction, would, of necessity, dissipate itself without satisfactory results, and the work done be lost in that yet to do.

WORK BEGINS IN GROUP OF THE THOUSAND COLUMNS

To this end the city was divided into a number of sections, each section char-

acterized by more or less architectural unity, and that selected as the point at which the excavators should begin their work was the Group of the Thousand Columns, an enormous construction covering, with all of its parts, more than twenty acres (see diagram to the right).



PLAN OF THE GROUP OF THE THOUSAND COLUMNS

The Group of the Thousand Columns covers an area of 20 acres, the great central court around which its several units are arranged containing more than five acres. The group derives its name from the principal architectural feature of this part of the city, the round column, of which more than a thousand have been found in its different temples, colonnades, and halls. The principal excavation made by the Carnegie Institution during the 1924 field season was in the Northeast Colonnade, which was completely cleared of all débris and fallen masonry. An enlarged plan of this edifice appears in the inset at the upper right corner.

This group was so named because its chief architectural feature is the column, some of which are square, others round; some sculptured and others plain. In the different colonnades, porticos, temples, halls, and minor courts surrounding the great Court of the Columns, the architectural center of the group, more than a thousand different columns have already been counted, ample to justify the name chosen for it.

The Court of the Columns contains five acres of ground. Originally it was paved with a hard lime-plaster, traces of which still are to be found at the edges, though toward the center this pavement has been destroyed by the forest which has everywhere thrown a green mantle over Chichen Itzá, since its final abandonment in the middle of the fifteenth century.

The north and west sides of the court are bounded by two very long colonnades of round columns with square capitals, each five columns in depth. The remaining sides are occupied by even more imposing buildings of greater complexity of ground plan, and it was in one of these, the Northeast Colonnade, that excavations were begun in 1924.

CLEARING THE ENTRANCES TO THE COURT OF THE COLUMNS

As a preliminary to this, however, it was thought advisable first to clear out the two principal gateways into the Court of the Columns, so that there might be convenient entrance, without having to climb over the fallen colonnades; and here actual digging was begun on May 28.

Photograph by S. Badia

NORTH GATEWAY TO THE COURT OF THE COLUMNS

The North Gateway to the Court of the Columns passes beneath the colonnade on the north side of this great plaza. It is 66 feet long, 4¾ feet wide at the bottom, with a corbelled roof, and 6½ feet high from the flagstone flooring to the capstone.

Photograph from the Carnegie Institution

SCULPTURAL DETAIL FROM THE NORTH GATEWAY OF THE COURT OF THE COLUMNS

Both ends of the North Gateway were flanked by pairs of handsomely sculptured figures. The one shown above is that of a jaguar (see text, page 89).

Photograph from the Carnegie Institution

THE SOUTHEAST CORNER OF THE NORTHEAST COLONNADE

The southeastern exterior corner of the Northeast Colonnade was rebuilt above the level of the cornice immediately on top of the sloping base, from the fallen elements of the façade which came out of the excavations at this point. The snake head and flanking rattles, one on each façade at this corner, were restored to their original positions and a few elements of the feathered bodies were added on either side. This work was completed on July 7, the day before President-Elect Calles, of Mexico, visited Chichen Itzá and inspected the excavations.

The gateway in the western side proved relatively uninteresting. The west colonnade is only two steps higher than the floor level of the Court of the Columns, and this gateway seems to have been a simple passageway between the columns of the colonnade without sculptural embellishment at either end.

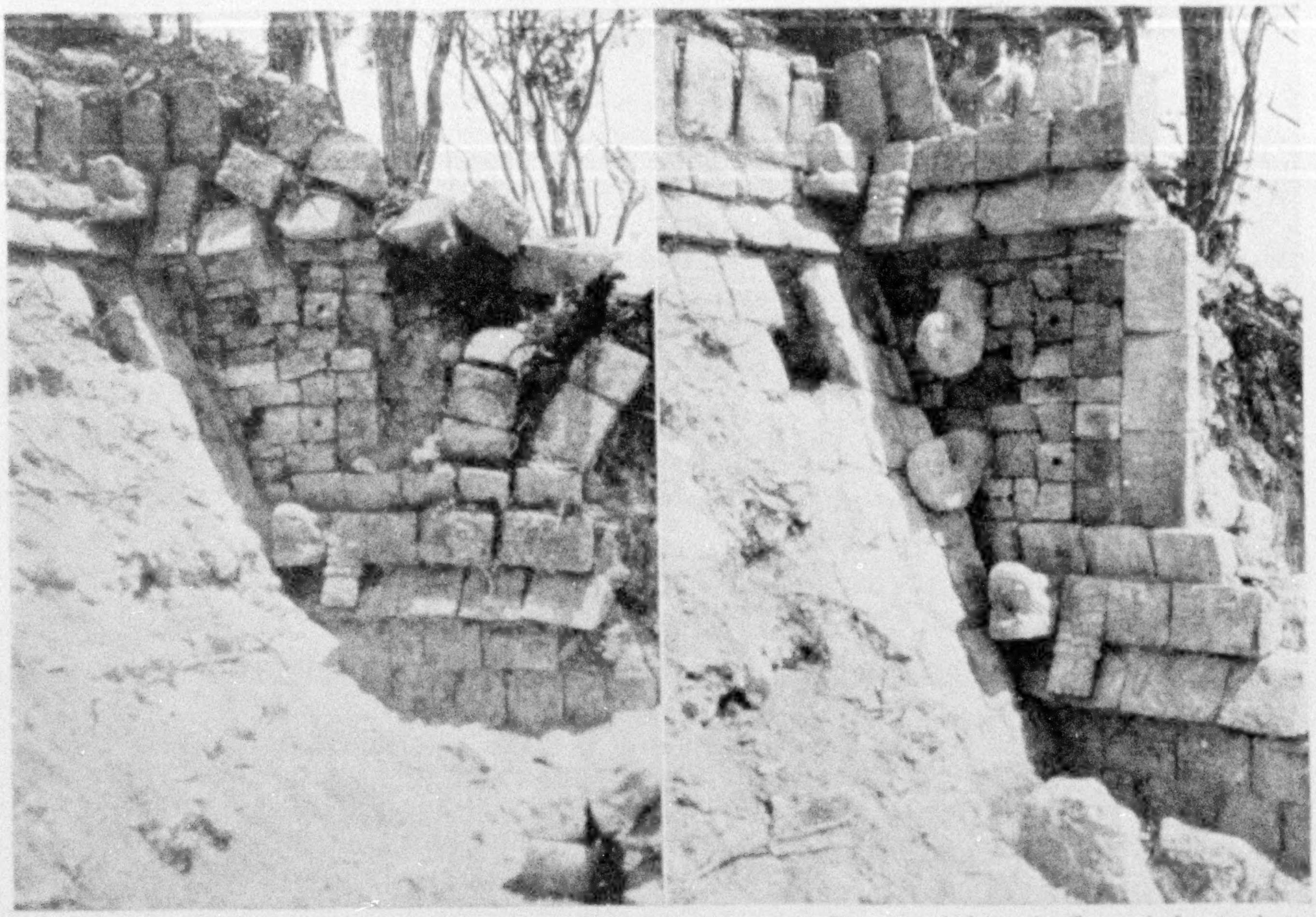
The northern gateway proved more interesting. The North Colonnade surmounts a terrace 7 feet above the level of the court, and it is through this terrace, or platform, underneath the colonnade proper, that the northern gateway passes (see page 88).

Both ends of this, it was found, had been decorated with flanking sculptured panels; the ones on the eastern sides at each end had jaguars carved upon them, whereas the western jambs were carved with macaws or parrots. Round shields and other jaguar and bird figures completed the sculptural decoration of this gateway, which was paved with well-cut flagstones.

EXCAVATION OF THE NORTHEAST COLONNADE

The principal work of the 1924 field season was the excavation of the Northeast Colonnade. This building faces south on a small square just east of the Court of the Columns. Directly behind it is a great natural depression several hundred feet in diameter and perhaps 30 feet deep, and its western façade is built against a higher building facing the larger court. This colonnade is 100 feet long, 49 feet wide, and 19½ feet high, rising from a low terrace 2 feet above the level of the square.

The arrangement is simple, dignified, and imposing (for ground-plan, see inset on page 87). It is composed of five tiers of square columns, ten columns in each tier except the front one, where the two end walls (the antæ) occupy the space of



Photograph from the Carnegie Institution

A CORNER OF THE COLONNADE "BEFORE" AND "AFTER" ARCHEOLOGICAL TREATMENT

The picture at the left above shows a mosaic panel after excavation, but before repair had been undertaken, the several motifs present being so badly shifted as to be scarcely identifiable. Beginning at the top, every stone was carefully removed and numbered until a course was reached which appeared to be solid and undisturbed. Next came the more delicate job of repair, and when this was completed the corner appeared as in the picture at the right.

two columns each, making a total of forty-eight for the colonnade.

The eight columns across the front divide the façade into nine doorways. All the columns are made alike—that is, in sections composed of large dressed blocks of limestone—and all are plain save the four central ones at the back, which are elaborately sculptured and inclose a sculptured throne or platform.

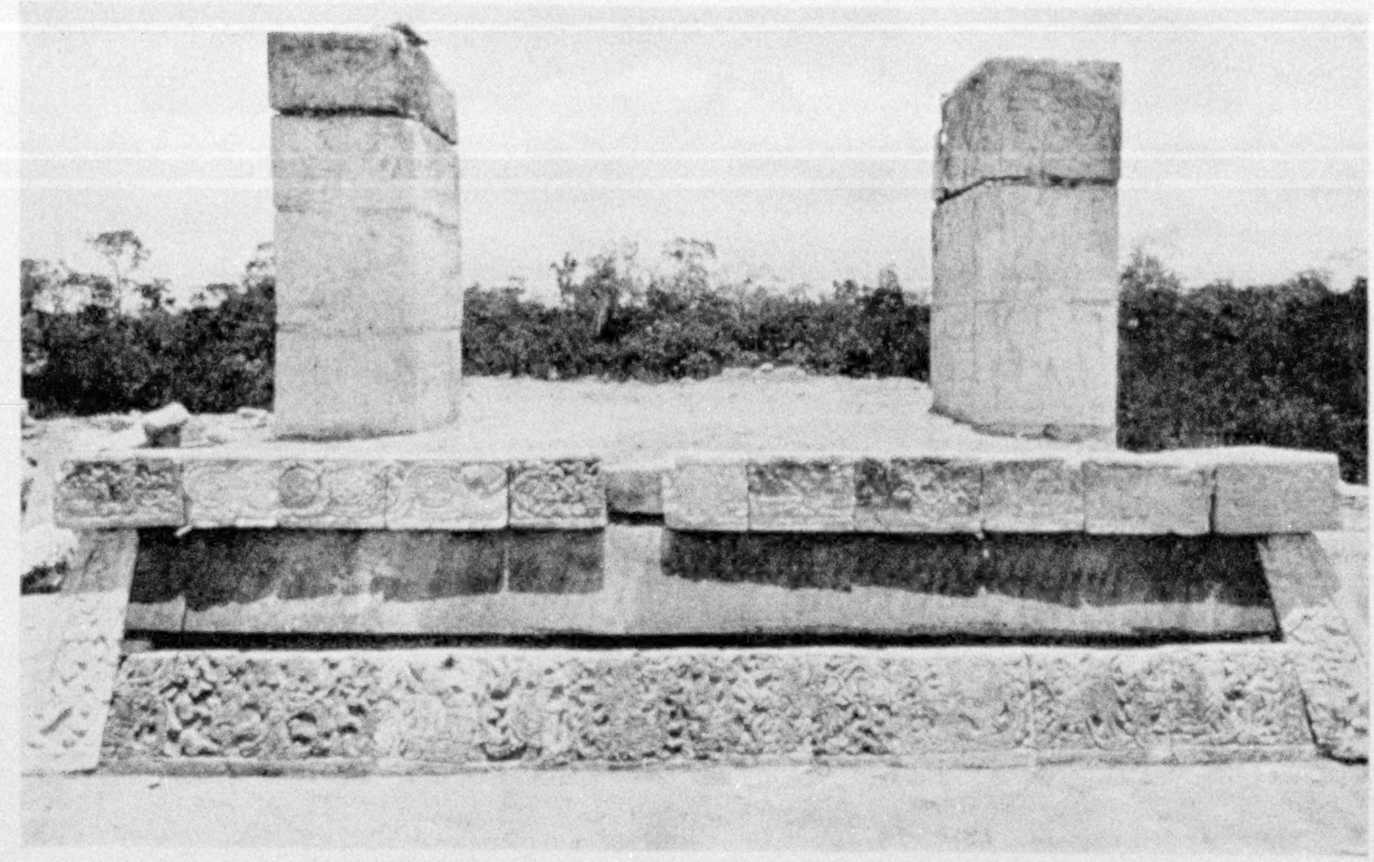
FITTING TOGETHER A GIANT JIG-SAW PUZZLE OF STONE

The upper part of the façade was composed of an elaborately sculptured panel, 93 feet long by 11 feet high, a mammoth mosaic of cut stone. The wreck of this latter, scores upon scores of intricately sculptured blocks strewing the terrace in front—feathers, shields, jaguars, macaws, elements of the famous Mayan mask panels, human figures, snake heads, snake tails and bodies scattered about in indescribable confusion—have constituted for the investigators, in their attempts to assemble them, a veritable giant's jig-saw puzzle, the individual pieces of which are heavy blocks of stone.

At each end of this long mosaic, and in the middle as well, there seems to have been a pair of mask panels, one above the other. This element is the most typical decorative motive of the New Mayan Empire. It is composed of two large square eyes, a great curling nose, a mouth with filed teeth, and square earrings. Parts of at least six of these panels have been recovered from the debris in front of the colonnade.

Three round shields, one above the other, came next, and, judging from the large number recovered in the excavations, these must have been a frequently recurring element in the decoration of the façade.

Above the next to last doorway, at each end, there was a human figure fastened to the wall by a tenon at its back. These are gorgeously clothed in featherwork cloaks, panaches of plumes rising



Photograph from the Carnegie Institution

THE RATTLESNAKE AND WARRIOR THRONE

The discovery of this beautiful dais, or throne, against the back wall of the Northeast Colonnade was the high point of the 1924 excavations. This throne is 13¼ feet wide across the front, 7¼ feet deep to the back wall, and 3 feet high. The pair of sculptured columns rise 5 feet above the level of its floor.

from their head-dresses, embroidered girdles, and jade necklaces, pendants, earrings, wristlets and anklets completing the costume. The right hand grasps a spear decorated with tufts of feathers, and the left an embroidered bag.

The building is surmounted by a cornice of the same style as the medial one. These two cornices are themselves extremely decorative. They are composed of three members, the top and bottom ones being plain, the former sloping upward, the latter downward. The middle member, however, is sculptured with a pair of intertwining rattlesnakes, a head and tail with plumed decorations at one end of the cornice and the other head and tail at the other end.

Imagine, then, this façade in its entirety; the nine ample doorways separated by solid square columns, the two rattlesnake cornices, the masks, shields, human, jaguar, and bird figures, this long and elaborately carved panel being painted from one end to the other with a variety of colors—red, blue, green, and yellow—the whole constituting a picture of dazzling and barbaric splendor difficult for the modern eye to visualize, however accustomed it may be to chromatic riot by our own flaming billboards.

A GREAT AUDIENCE HALL OR TRIBUNAL

Passing into the cool shade of the colonnade through the middle doorway and walking toward the back, one passes between the outer pair of sculptured columns, also painted, and stands before a dais or throne, the sides of which are sculptured with lines of warriors, and the cornice with intertwining rattlesnakes running around the top. It is flanked by the inner pair of sculptured columns (see illustration above).

All four sides of these four columns are sculptured, making a total of sixteen panels. Most of the subjects are warriors elaborately clothed in feather-work, embroidered cotton stuff, and jade jewelry, and armed with spears, clubs, and shields. An interesting exception is the front of the back column at the left, which is carved with the representation of Kukulcan, whose likeness is to be seen everywhere in this part of the city. Along the back and side walls run low

Photograph from the Carnegie Institution

THE NORTHEAST COLONNADE FROM THE FRONT

The principal excavations of the 1924 field season were centered here. When digging was begun at this point, on June 2 last, nothing appeared above the level of the ground except the front row of columns, the four back rows being covered to their tops with the fallen masonry of the roof. When excavations were closed, six weeks later, this beautiful example of New Empire architecture had been completely uncovered and partially repaired. Including the small addition at the eastern end (see the inset on page 87), the Northeast Colonnade was 100 feet long, 49 feet wide, and 19½ feet high. It is composed of 48 square columns 8 feet high and 2 feet square. In the middle at the back, between a pair of sculptured columns, the justly famous Rattlesnake and Warrior Throne was found, the most important part, the center of interest of the entire colonnade (see page 91).

benches, somewhat lower than the dais just described.

Standing within this large colonnaded hall, with its vaulted roof, now unfortunately fallen, and facing the Rattlesnake and Warrior Throne, one is strongly impressed that this was no temple or sanctuary, but rather an audience chamber, a council hall perhaps, or some tribunal where justice was dispensed.

Mayan temples are of an entirely different type; they are usually composed of a much smaller outer corridor and an inner sanctuary surmounting a more or less lofty pyramid (see pages 68, 72, 73, and 77).

One important feature brought out by the excavations was the several changes which the colonnade had undergone in ancient times. At least two and probably three of these were noted, all of which detracted materially from the original beauty and unity of the design.

The first modification which it suffered was the construction of a small L-shaped portico against its eastern end, the round columns of which are of spindling proportions and crude, rough workmanship. This considerably marred the fine exterior proportions of the original building.

A second modification within the building did equal damage to the interior. At the northeastern corner, secondary walls had been built inclosing six of the columns, making a chamber by itself within the colonnade, but cut off from it, as shown by the ground-plan inset on page 87, where these secondary walls are indicated by dotted lines. This reduced the generous proportions of the original hall.

THE MAYAN ARCHITECTS BUILT POOR ROOFS

A third modification, though one which arose from dire necessity, was to all but destroy the original idea.

There is ample evidence from the 1924 excavations that already, in ancient times, the roofs of these colonnades had begun to weaken and give way beneath the tremendous weight of masonry above them. Mayan roof construction, a series of corbels approaching each other until close enough to be bridged by a capstone, was at best the weakest factor in their buildings; but when such unstable masses of masonry were built upon wooden beams, laid across columns having a 9-foot span, the Mayan masons were courting disaster, which was not slow in overtaking them, even in their own day.

It became necessary before the Northeast Colonnade was finally abandoned to strengthen the roof beams in its northwest corner. This was done by building a stone wall from the level of the floor to the bottom surface of the beams, which were giving way, and no doubt saved the situation for a time (see page 94).

HUMAN STATUETTES USED TO PROP UP A FALLING COLUMN

These sustaining walls are the crudest masonry in the building, and the masons who laid them did not scruple to destroy the sculptured dais itself, in what appears to have been a hasty search for conveniently sized building blocks, since several pieces of the intertwining-serpent cornice of the dais were found in this roughly laid wall.

But the last occupants of the Northeast Colonnade had other structural troubles to worry over beside falling roof beams. It has been explained that this building stands just south of a large, deep, natural depression—indeed, the whole back part of the terrace from which it rises appears to be artificial, having been built up from a considerable distance down the slope.

Even before the building had been abandoned, this fact seems to have caused further structural trouble. The back part of this terrace had begun to settle into the depression, giving rise to an alarming tilting outward of the back tier of columns.

Heroic efforts would again appear to have been made to save the building from destruction. Walls were built between the bench along the back wall and the back columns to keep them from shifting outward, and in one place five Atlantean figures or human-like statuettes, were hurriedly pressed into service to accomplish the same end. These were wedged in tightly—three face downward, one standing on his head, and the other upright—in which position they had served honorably, since the column thus braced had not shifted where they "carried on."

Photograph from the Carnegie Institution

SECONDARY WALL BUILT BETWEEN COLUMNS TO PREVENT THE ROOF FROM FALLING

The Northeast Colonnade began to fall to pieces in ancient times, even before it was abandoned. Particularly the roof beams began to give way beneath the tremendous mass of solid masonry built on top of them. In a frantic effort to save the roof, the last inhabitants of the city built hastily constructed walls of the crudest sort, from the floor to the roof beams, between the columns. The search for stone to put in these supporting walls seems to have been so hasty, indeed, that they did not scruple from laying vandalistic hands upon the Rattlesnake and Warrior Throne and tearing from the cornice some of its sculptured blocks (see illustration, page 91).

The history of this building, which must date from after 1000 A. D.—that is, after the entrance of the Toltec-Aztec influence at Chichen Itzá—is fairly clear from the excavations. The colonnade as originally planned, with its forty-eight columns, is by far the best part of the structure; its building blocks are better dressed and no re-use of elements from other older structures is seen.

Some time after the original colonnade had been completed, a single-room sanctuary was built on top of the high building to the west of it and against which it abuts. In order to reach this, a high stairway was built along the western end of the front of the colonnade, completely hiding it. While this must have seriously impaired the beauty of the building in ancient times, it happily preserved for posterity the only part of the façade above the medial cornice—that part bearing all the sculptured decoration—which has come down to us and has given us not only the original height of the building, 19½ feet, recoverable nowhere else, but also indicated the general arrangement of the several elements of the mosaic—important points indeed (see illustration, page 90).

STRAGGLERS REMAINED AFTER THE CITY WAS ABANDONED

After Chichen Itzá was abandoned, in the middle of the fifteenth century, and the Itzá had withdrawn from Yucatan back toward the south, whence they had originally come, it is highly probable that a few stragglers lingered on in the deserted city and sheltered themselves here and there in its empty temples and palaces.

Some such use appears to have been made of the Northeast Colonnade after the city was generally abandoned, and it is to these last straggling occupants that the hastily constructed walls at the back to prevent the roof beams from falling are due. To their impious hands, forced, perchance, by dire necessity, we may ascribe the violation of the Rattlesnake and Warrior Throne, sculptured frag-

Photograph from the Carnegie Institution

STAFF OF THE CARNEGIE INSTITUTION CHICHEN ITZÁ PROJECT

From left to right: J. O. Kilmartin, engineer United States Geological Survey; Monroe Amsden, assistant archeologist and paymaster; E. H. Morris, archeologist in charge of excavations; Mrs. Morris, and S. G. Morley, Associate of the Institution in charge of the Chichen Itzá Project. The wreck of the expedition's only phonograph, an "archaic" model, strews the table in the foreground, an irreparable loss.

ments of which were found built into these last crude walls (see page 94).

Charcoal, potsherds of crude workmanship scattered here and there about the colonnade, a single jade chisel, tell the tale, eloquently enough, of shoes too large for feet grown suddenly small, a final uncertain occupancy of halls designed for more formal occasions, a last feeble flicker before the light went out.

TEMPLE SITES YIELD FEW ART OBJECTS

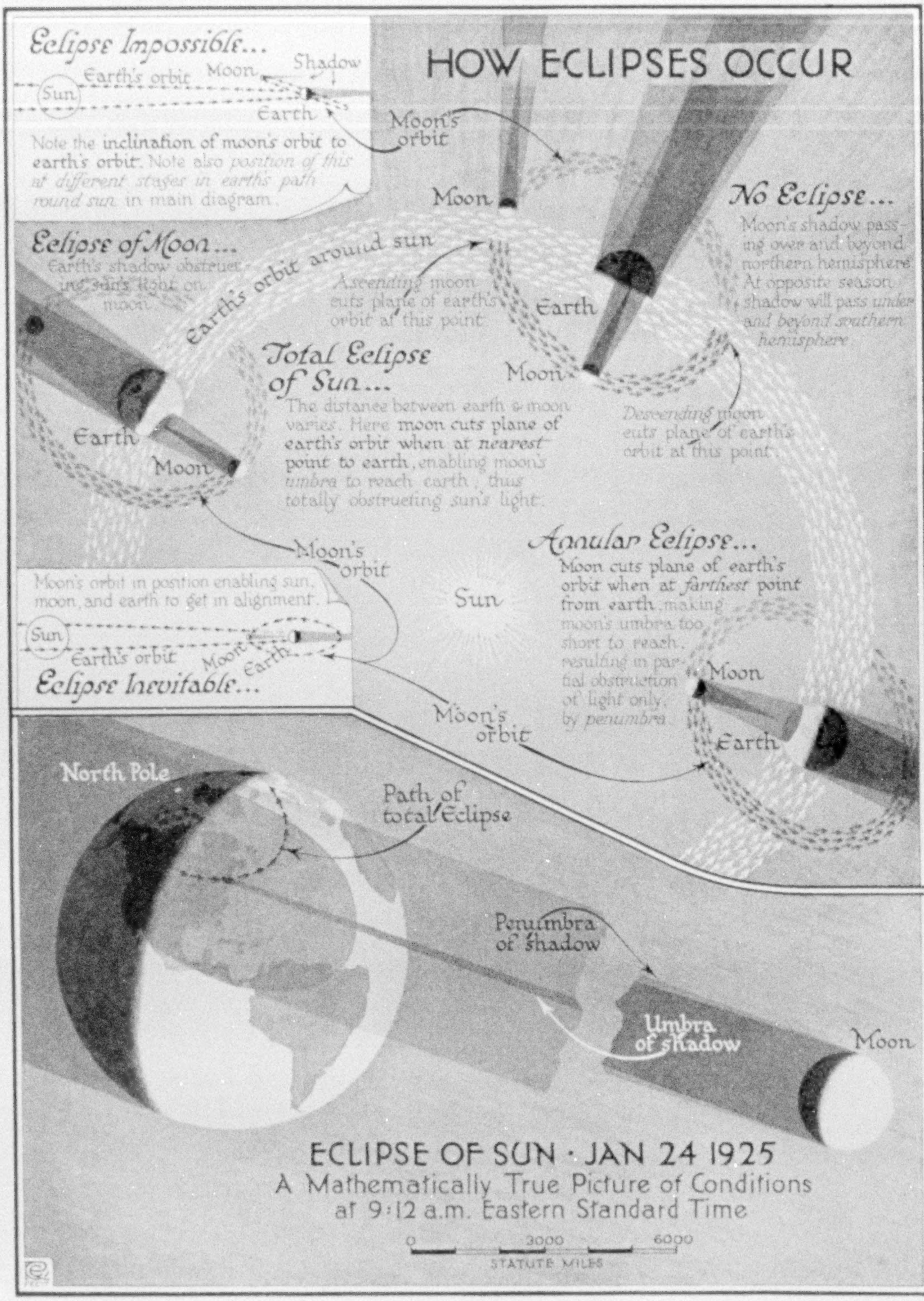
The yield of small objects, ceramics, obsidian knives, jade beads, earrings, etc., was very small, though this had been anticipated. Digging in public buildings is always far less profitable than in tombs and dwelling sites. Temples and palaces were rifled of their treasures before they were abandoned. It is only the homely cooking-pot of clay, the humble corn-grinder, and the polishing-stone that were left behind at the moment of departure, too heavy or too simple to be borne away over long trails to new homes, these and the sacred objects with the dead.

This has been the almost universal experience in American archeology, and it was not to be expected that it would be reversed here. In subsequent seasons tombs will be located, and here the return of smaller objects will undoubtedly be much larger.

The Maya buried their most cherished possessions with the dead, each according to his trade—the huntsman with his favorite spear, the potter with his best-loved bowl, the priest with his books of divination and ritual—and it is certain that part, at least, of this material culture will be recovered as the work proceeds.

To-day how different is the story from that of other times. Silent are the temples, courts, and colonnades; gone the rulers, priests, and sacrificial victims; gone the artisans and builders; gone those humbler folk whose unremitting toil alone made all this pomp and pageantry possible—back to Mother Earth, enshrouded by the living green of tree and bush and flower.

But of a moonlight night, standing on the lofty terrace before the palace of the Itzán kings, the silent city at one's feet, the temples and pyramids rising white and spectral above the dark forest, breezes whispering through the trees bring stirring tales of other days, other men, other deeds, and he who would may listen then and hear.



© National Geographic Society Computed and drawn by C. E. Riddiford and A. H. Bumstead

A PICTORIAL DIAGRAM OF THE CAUSE OF ONE OF THE MOST DRAMATIC SPECTACLES IN NATURE

Those who observe the great celestial performance this month (see text, page 97) will never see it again in the same "theater," for the sun and moon never repeat their "act" along the same circuit within the span of a generation. A clear sky will provide a spectacular event for all beholders along the path of totality. The upper half of the above illustration is diagrammatic and is not drawn to scale.

INTERVIEWING THE STARS

How Twentieth Century Astronomers are Inducing the Heavens to Reveal Their Secrets

By William Joseph Showalter

Author of "Exploring the Glories of the Firmament," "Exploring the Mysteries of Plant Life," etc., etc., in the National Geographic Magazine

ON THE 24th of January the sun and moon are scheduled to stage another of their great periodic dramas in which the Empress of the Night for a few brief minutes banishes the King of Day and rules the diurnal sky.

Only those who have the choice seats directly in front of the center of the stage will be able to get the full benefit of the act. They will be in a strip of territory about 70 miles wide, stretching in a southeasterly direction from a point northwest of Duluth, into the Atlantic Ocean between the upper part of New York City and Newport, Rhode Island.

To the laity the moon will reveal her own utter lack of histrionic abilities; for as she glides between them and the sun they will discover that she is merely a supernumerary, able only to reflect some of the light of her principal on the celestial stage.

But the astronomers who will gather to observe the spectacle will not be interested in the fact that, getting the center of the stage, the moon loses all her borrowed light, and therefore can only be seen as a disk of blackness—an ink spot over the face of the sun.

Rather, they will be interested in the haze of light that appears around the circumference of the lightless moon, for that is the chromosphere of the sun, and it holds many secrets. Also, they will want to see the stars that shine immediately past the edge of the blotted-out sun, for their position may shed new light on the Einstein Theory.

WHAT IS THE GOOD OF IT ALL?

Meanwhile the man in the street will be wanting to know what is the use of such investigations anyway; and if the astronomer takes time to answer, it will be to say, "I don't know."

Nor can anyone foretell what new truths will be discovered, or foresee what new applications to human welfare they may have.

But new scientific knowledge always has a way of turning men's minds to its application to human necessities.

To-day, in peace times, we see the proud American-built *Shenandoah* crossing and recrossing the continent from east to west and from north to south, without fear of the gas explosion which has wrecked so many superb lighter-than-air craft.

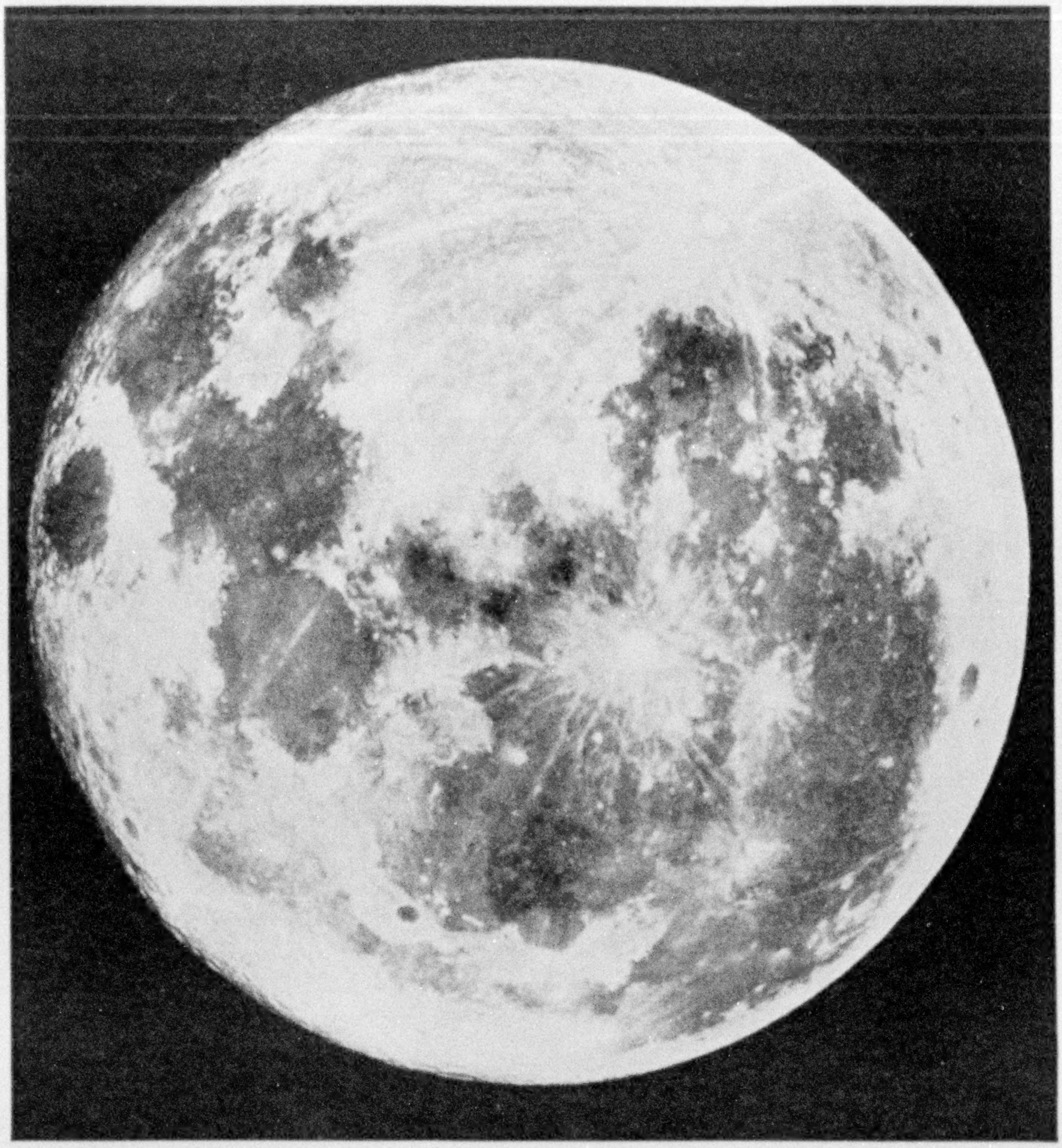
And all largely because Lockyer, in 1868, training his spectroscope on the great flames that shoot out from the rim of the sun, detected a new line in their spectrum. He noticed its close resemblance to the lines of hydrogen and concluded it must be the spectroscopic signature of a light gas unknown to terrestrial chemists.

Twenty-eight years passed, with everybody thinking that this gas was a stranger to the earth. Then Sir William Ramsay obtained minute quantities of a new gas from uraninite. Imprisoned in a test tube and electrically excited, it began to glow. Studied with the spectroscope, it showed the same telltale autograph that Lockyer had observed.

A COLLEGE PROFESSOR'S CONTRIBUTION

Later physicists found that when radium disintegrates it produces this same gas, and that it signs itself with the identical superscription that Lockyer found in the light of the terrific eruptions on the rim of the sun and Ramsay discovered in his test tube.

More years passed. The World War was on, and America had entered it. The housewives of the plains of Kansas had been complaining of the quality of their



Photograph from Yerkes Observatory

THE FULL MOON VIEWED THROUGH A TELESCOPE OF MODERATE SIZE

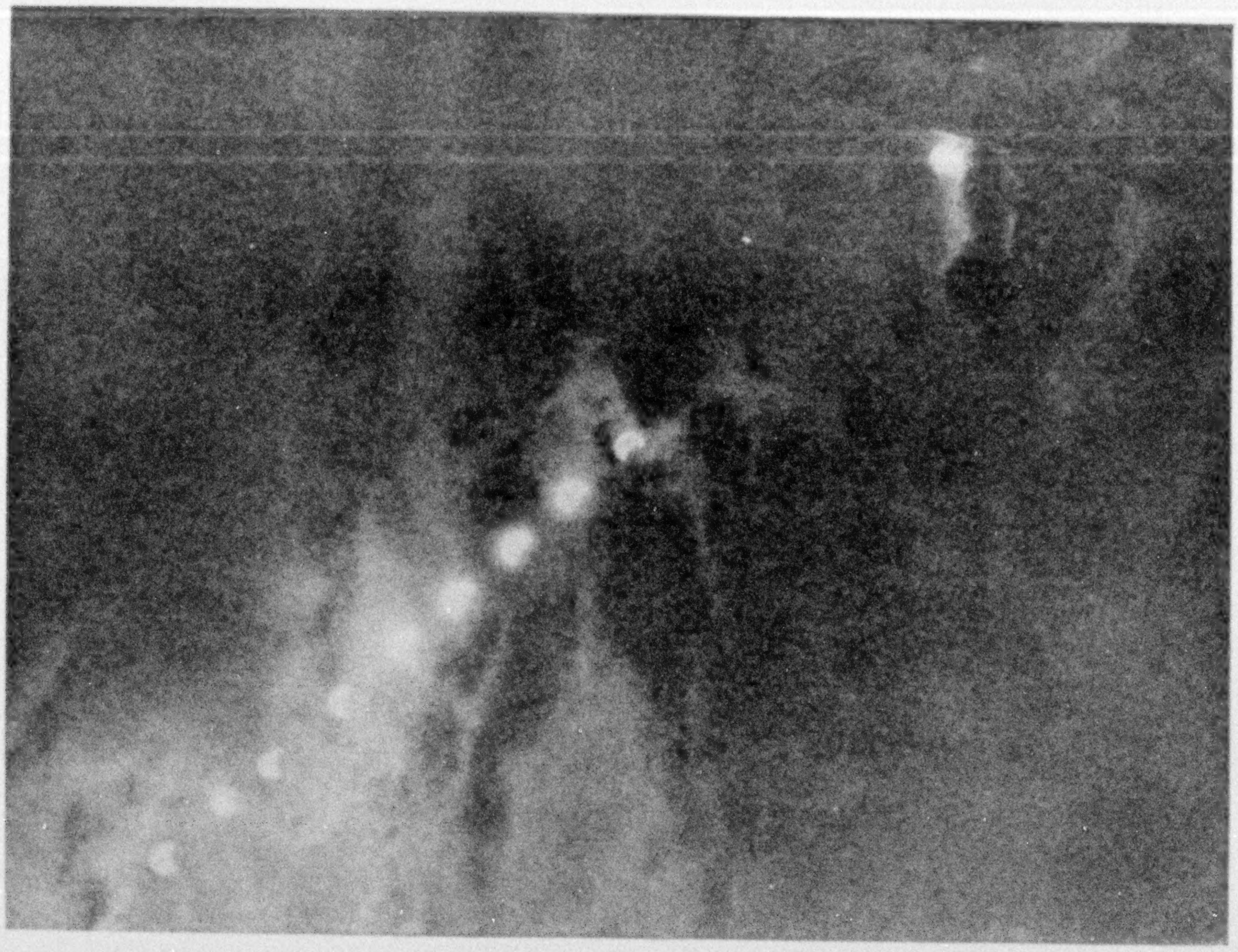
The work of Dr. Charles G. Abbot, of the Astrophysical Observatory of the Smithsonian Institution, in studying the variations of the temperature of the sun and in devising methods of harnessing solar energy to the multiplying needs of our civilization, constitutes one of the classic investigations of astronomy. He has discovered relations between fluctuation of solar temperature and the weather that promise to make long-range weather forecasting possible, and has devised a solar cooker that met all the needs of his household on Mt. Wilson.

natural gas. It didn't make enough heat or sufficient light.

A middle-western university professor, H. P. Cady, was sent down to find the trouble. In his spectroscope appeared once more the unmistakable signature that had come to Lockyer, Ramsay, and to Sir Ernest Rutherford in his manifold investigations of radio-activity.

It told him why that gas wouldn't produce sufficient heat and light—it contained helium, as inert as stone and playing the same rôle in the natural gas that slate plays in coal.

Then the American Chemical Society met. The university professor was put on the program to tell of his discovery. But the war was at its height, and the chemists of the Allied nations were there to discuss how chemistry could help solve



Photograph by the Keystone View Co.

A SERIES OF PHOTOGRAPHS, TAKEN AT SHORT INTERVALS, SHOWING A PARTIAL ECLIPSE OF THE SUN AT SCRANTON, PENNSYLVANIA

In 1900, when numerous expeditions went to Georgia to view the total eclipse, one astronomer, who had followed such events around the earth for more than a third of a century, but had always had to work with his back to the sun in the operation of his instruments, took his wife along. She counted off the seconds, and when there were only five seconds left, he turned to look. His enthusiasm at what he saw probably surpassed that of any other member of any expedition that year. Some astronomers have gone on ten expeditions, traveling over 100,000 miles and getting in less than half an hour's actual observation for the whole series of expeditions.

the paramount concern of the nations in arms—how to win the war.

One chemist after another made his contribution to the discussion. Then came the modest professor. He apologized for intruding a theme upon the attention of that great body which could not, by the longest stretch of his imagination, have any bearing on the momentous issue before which all other matters should stand silent.

But after he spoke a venerable British savant declared that he need offer no apology; that if the war went on another two years the professor's contribution would do more to promote victory than all the other contributions to the proceedings.

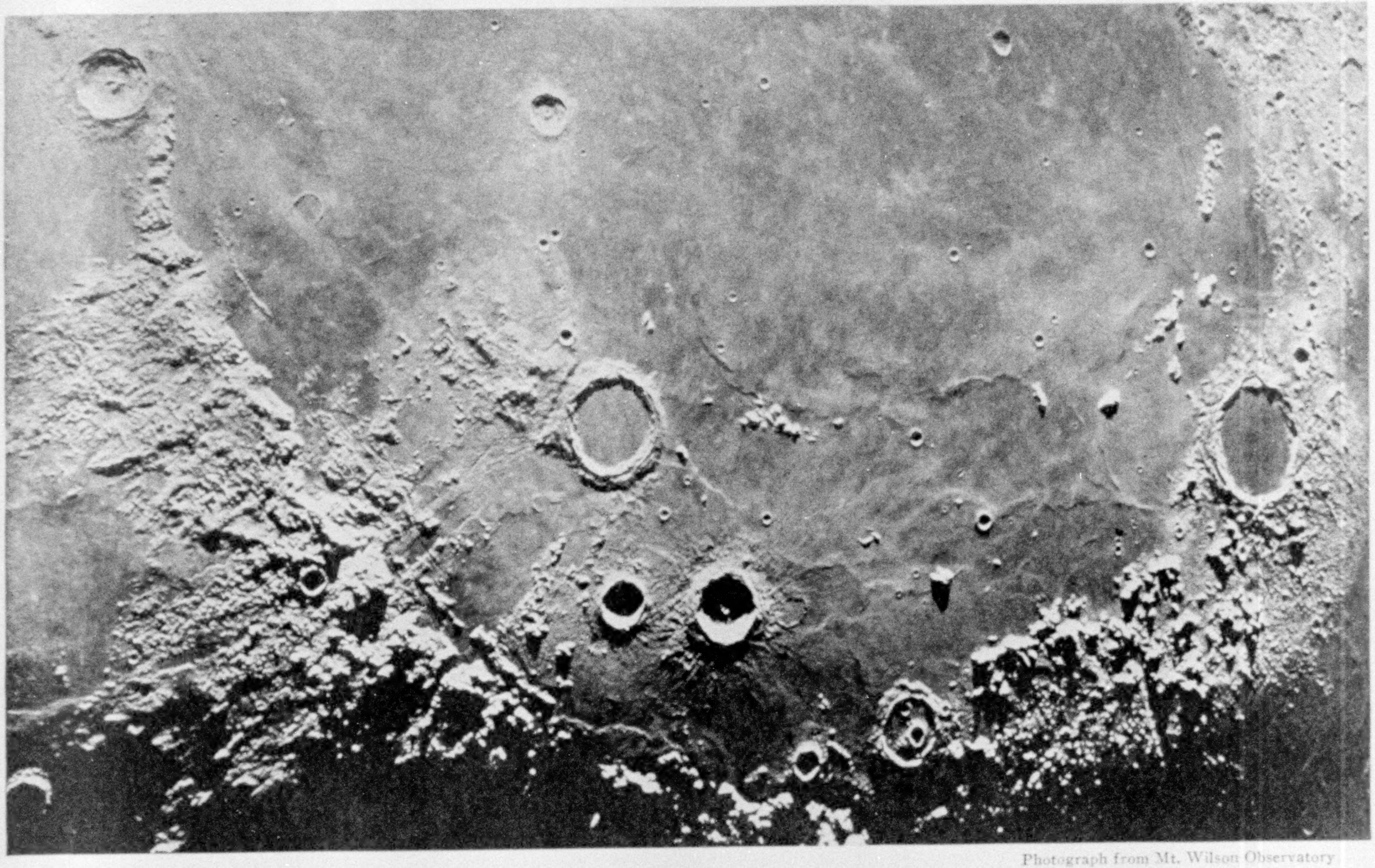
Thus came helium as the straw that would break the Hohenzollern back, if all other weights should fail. It made possible the construction of giant dirigibles which could conduct raids over the enemy lines without fear of inflammable bullets.

And it was the training of a spectroscope on a huge flame on the rim of the sun during an eclipse that had first revealed this element.

Romance? Astronomy offers more thrills to the alert human mind than all the fiction in the Library of Congress could provide!

THE TELEPHONE RELEASED FROM WIRE BONDS

The American people listened in on the election returns that gave Mr. Coolidge the tribute of a just servant, and marveled once more at the wonders of radio.



Photograph from Mt. Wilson Observatory

A BIRD'S-EYE VIEW OF A LUNAR LANDSCAPE THROUGH THE 100-INCH TELESCOPE

The mountain at the right, near the large poollike crater, is the same height as Mt. Wilson. The small white splotches at the bottom of the picture are the summits of lunar peaks bathed in the glory of the setting sun. Standing on Mt. Wilson and watching the shadows fall on the slopes of San Jacinto, while its summit still towers into the sunlight, and then, at night, looking through the telescope and seeing the summits of lunar peaks aglow in the same way, is a thrilling experience.

But they little dreamed that a patient Danish astronomer had done the pioneer work which released Bell's telephone from the bondage of wires and made the ether of space its servant.

Yet when Roemer found that eclipses of the moons of Jupiter occurred sixteen minutes earlier when Jupiter and the earth were on the same side of the sun than when on opposite sides, he deduced that light was not instantaneous, but traveled at about 186,000 miles a second.

Clerk Maxwell concluded that light, to travel at such a velocity, must be electromagnetic, and that there must be other wave lengths than those which register on the human eye.

Hertz detected these hypothetical waves, Marconi harnessed them to signaling, and Pupin made them the burden bearers of sound. Vacuum tubes can now take the infinitesimal bit of energy these waves possess after spanning a continent—a bit of energy no greater than a billionth of that expended by a fly in crawling up a windowpane—and, "stepping them up" and amplifying them, make them capable of producing a room-filling sound.

Nor is this the mouth of the majestic stream of consequences that started in the little spring of Roemer's observation of the eclipses of the moons of Jupiter.

The ether waves have been made to reproduce light as well as sound, and radio pictures have hurtled through the air from Washington to Philadelphia.

RADIO MOVIES COMING?

Furthermore, they have been made, experimentally, to carry 16 such pictures a second, which means radio movies. So far has the work progressed that conservative scientists believe the people of the United States, in their own homes and clubs, will be able to "see in" as well as "listen in" on the inauguration of the successor of President Coolidge, in 1929.

Many are the things that astronomy has done for the race, besides leading it away from such narrow beliefs as the doctrine that the earth is the center of the universe, and that the latter revolves around our pigmy globe.

But the man with the telescope, the spectroscope, and other space-sounding instruments still has many problems that challenge him, the solution of any one of which may mean even more to human well-being than the work of Roemer or Lockyer.

For instance, there is the problem of wireless transmission of electric power. As our coal reserves approach a state of exhaustion and our oil wells go dry, a race that is expanding at an unprecedented rate must solve anew the greatest problem of civilization—the problem of power for industry.

In his astronomical dome and his physical laboratory, the astronomer measures the heat of the sun about as accurately as we take the temperature of the water for our morning baths.

How much energy does Old Sol send into space? The estimates of Langley and Abbot indicate that if a layer of the best anthracite coal 15 feet thick, covering the entire surface of the sun, could be burned in a single hour, the energy released would not be greater than that which the sun gives off in that length of time.

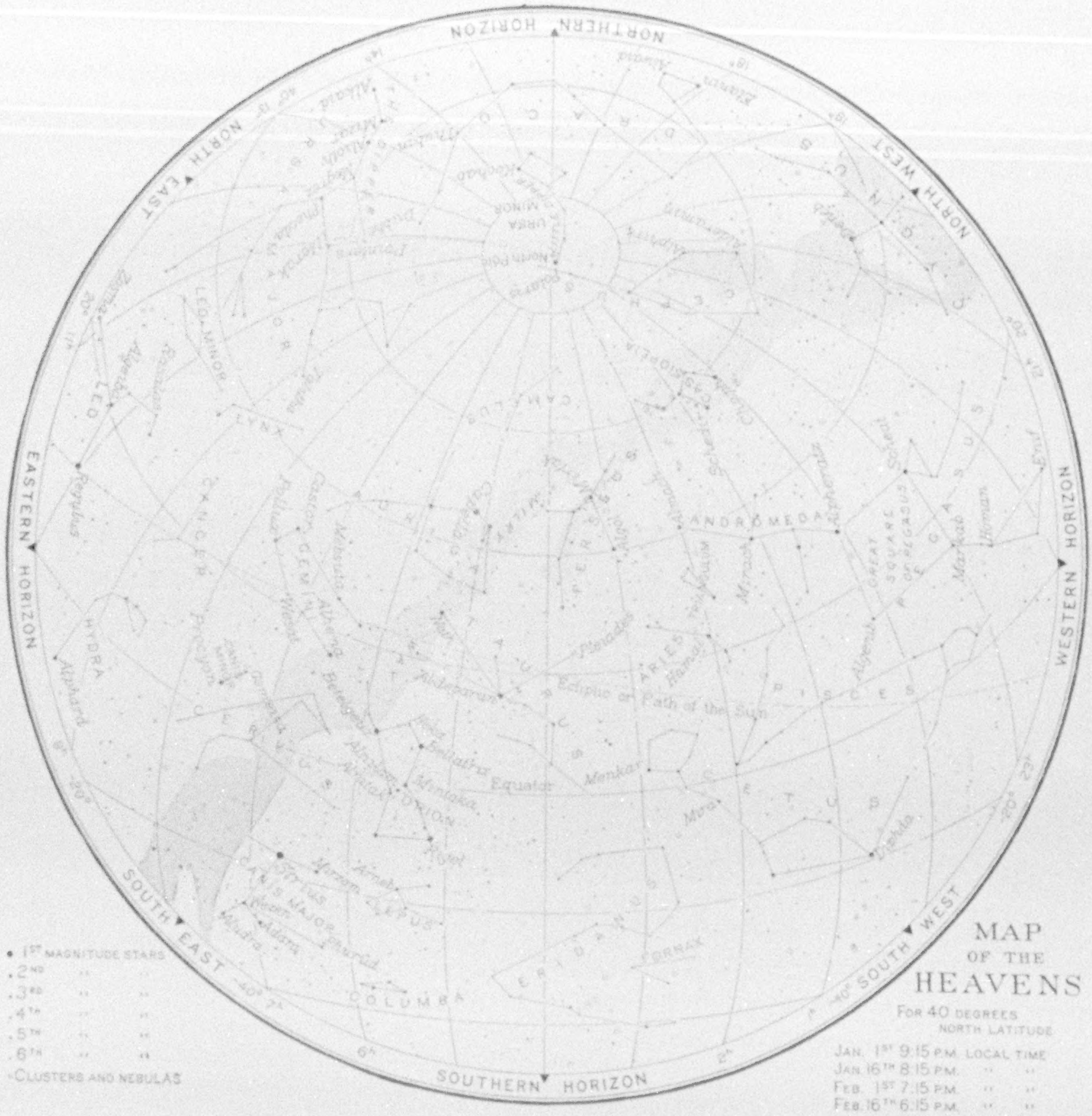
How much of that heat comes to the inhabitants of the earth? Nordmann, in his fine book, "The Kingdom of the Heavens," says 265,000,000 horsepower every 24 hours.

Down through 93,000,000 miles of super-arctic space, where temperatures exist beside which the bitterest cold of the polar regions would seem balmy in comparison, the sun sends us this vast supply of energy, day in and day out.

Some there are who hope the study of the sun may bring lessons that will result in radio power transmission and the utilization of desert sunshine as heat and light and power for the peoples of the fertile plains.

MATTER THAT WEIGHS 25 TONS TO THE PINT

Here is an inkling of a different kind of solution of the problem of power sources after coal and oil supplies are gone. Studying our friend Sirius, the gay Dog Star, and his less brilliant companion, astronomers have found indications that this satellite of the Dog Star has nearly as much mass as the sun, although it is only a little larger than the earth. The evidence is persuasive.



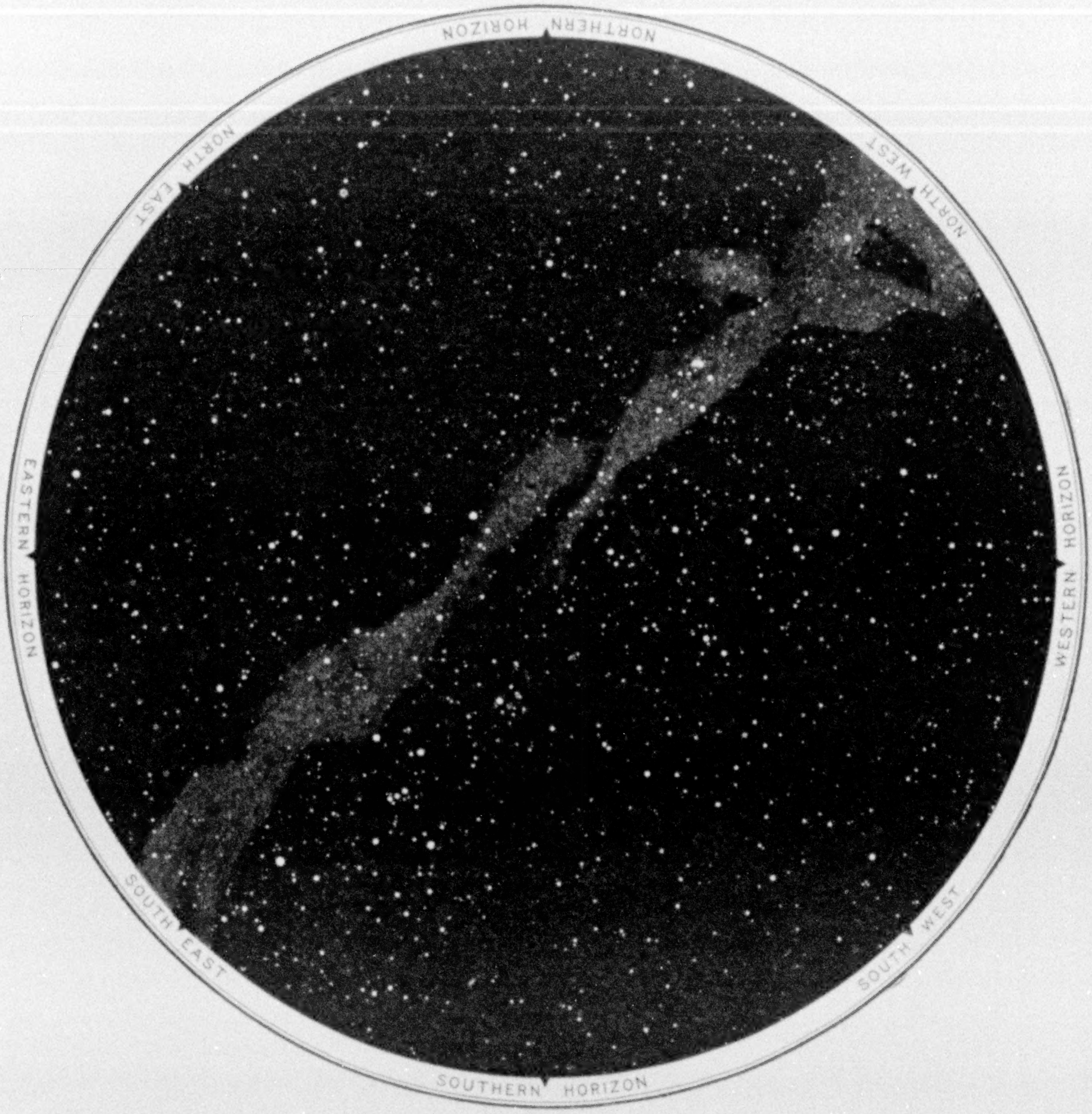
Drawn by Albert H. Bumstead, © National Geographic Society

A CHART OF THE HEAVENS VISIBLE IN THE UNITED STATES AND SOUTHERN CANADA DURING JANUARY AND FEBRUARY

The lines on this chart corresponding to meridians are separated from each other by the distance the stars appear to move across the sky in one hour. The lines corresponding to parallels show the direction of the stars' paths from the time they rise to the time they set. By remembering that the stars within the space bounded by two meridian lines sink into the western horizon every hour, and that a corresponding stretch of new sky rises out of the east in the same time, the major portion of the chart will be usable hours before or after the time indicated in the table at the right. Stars near the North Pole, like the Great Dipper, never set; the daylight merely puts them to sleep. For a corresponding chart of the heavens during the summer months, see page 170 of the August, 1919, GEOGRAPHIC. To get the correct position of the stars, hold the chart overhead, with the horizon marks pointing in their proper direction.

If that be true, then there are states of matter of which man never dreamed before. On that basis this dark star would be 50,000 times as heavy as the same bulk of water. In other words, a pint of the material composing that star would weigh 25 tons.

The world is looking for a good conductor of electricity that will enable industry to transmit power long distances without undue loss of energy. It is possible that this new understanding of the constitution of matter might lead to the open door of a new and better conductor



Drawn by Albert H. Bumstead, © National Geographic Society

A PICTURE MAP OF THE HEAVENS CORRESPONDING TO THE CHART OF THE STARS PRINTED ON THE OPPOSITE PAGE

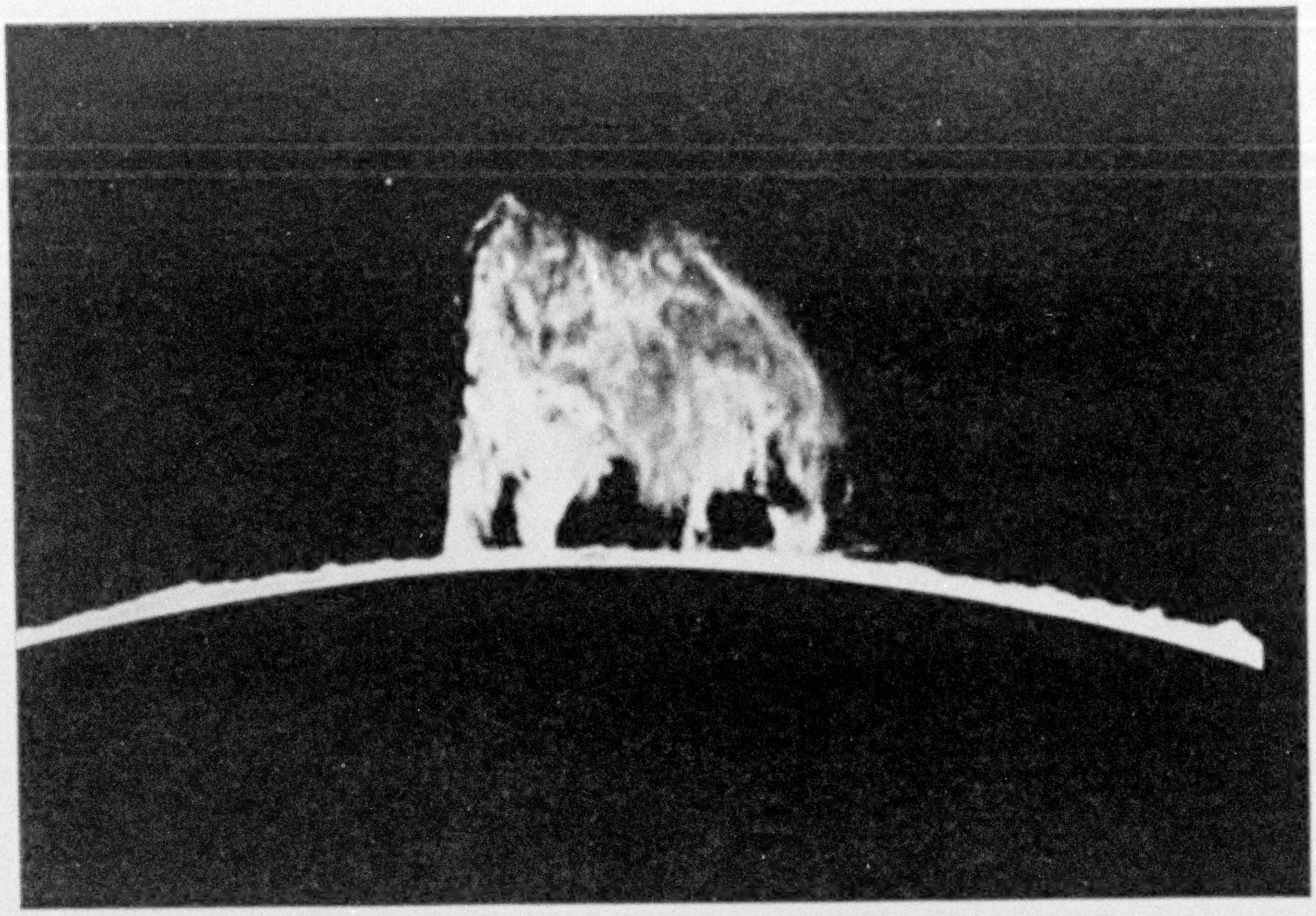
to take the place of the diminishing supply of copper in the transmission of electrical power.

Should such a conductor be found, then the melting snows of the Rockies and the Andes, of the Alps and the Himalayas, might turn the wheels of the world's industries, light the lamps of its homes, and produce all the fires of its kitchen ranges and sitting-room fireplaces.

From the darkened dome that houses his instruments, the night-working astronomer day-dreams of yet other forces that may free the world from the bondage of cold and hunger in the times that far-visioned men discern in the distance.

BREAKING DOWN THE ATOM

If the sun withholds its secret of wireless transmission of power, and if the companion of Sirius refuses to tell how to make denser materials than the earth possesses, there is some basis for the hope that at our own doorstep shall yet be found infinite sources of power that mankind has stumbled over for generations!



Photograph from Yerkes Observatory

"THE WOOLLY ELEPHANT" PROMINENCE ON THE RIM OF THE SUN

The vast eruptions on the surface of the sun send out huge columns of flame that shoot out hundreds of thousands of miles into space at immense velocities. If similar flames poured out from the surface of the earth, they would engulf the moon. Some of these assume bizarre shapes, as in the case of the "Woolly Elephant." Formerly they could be photographed only at times of total eclipse, but the invention of the spectroheliograph makes it possible to photograph them whenever the sun is shining.

The astronomer and the physicist have pooled their forces in cross-examining the atom. In the test tubes of the laboratory and the cosmic crucibles of the skies, they are attacking it with X-rays, spectroscopes, and other instruments of atomic torture, to make it surrender the secret it has withheld from humanity for so long.

When Madame Curie discovered radium and Röntgen produced the X-ray they gave the world an inkling of the unheard-of powers that dwell within these infinitesimal solar systems; and with inconceivably small amounts of this power the physicist is bombarding the atoms to break them up, while the astronomer is studying the forces that affect them in the sun and the fixed stars.

Man has increased his power as he has appealed to smaller units for it or resorted to more complex qualities of these units.

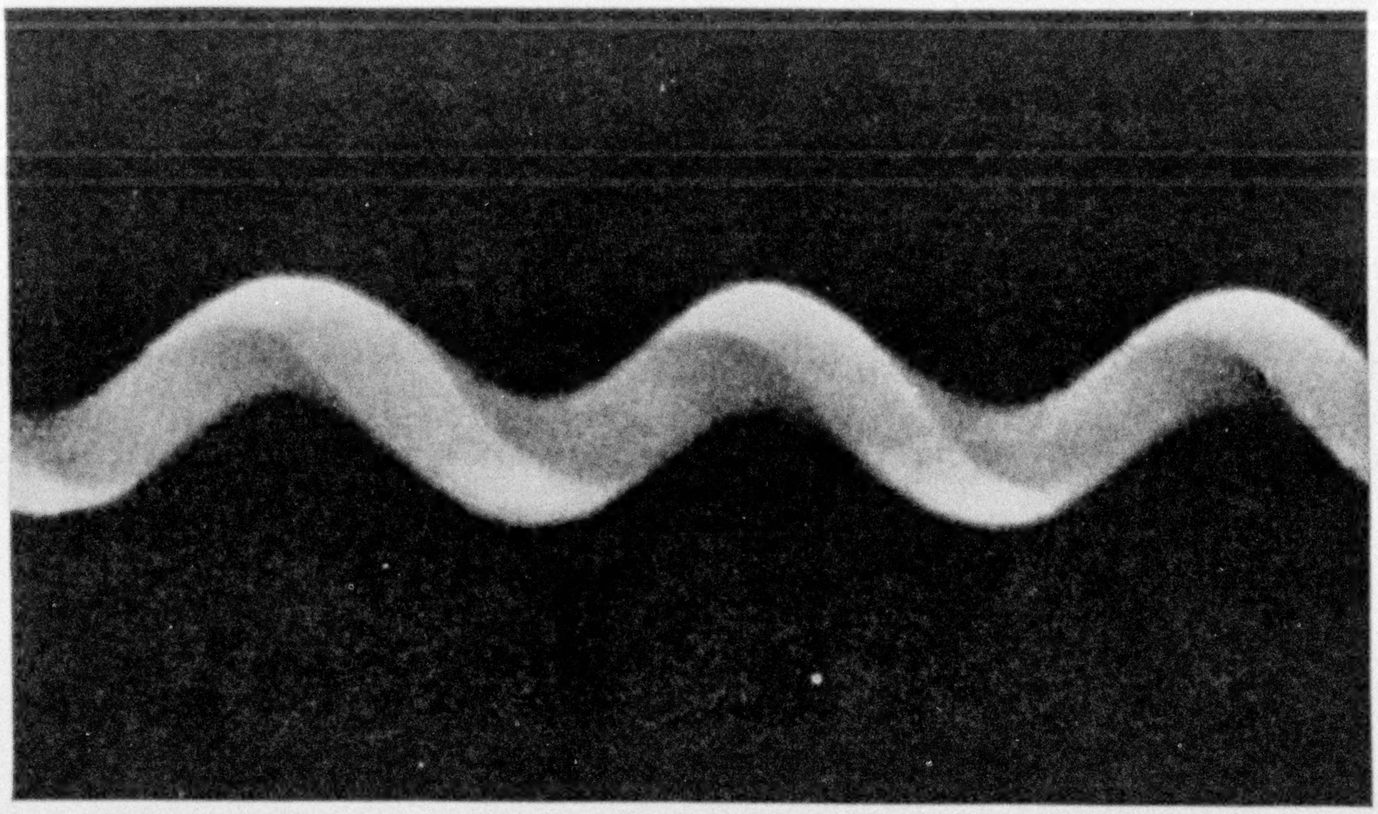
His first use of power, other than that of his own good strength, was a collection of cells—a dog, a horse, an ox.

Then he breasted a stream and faced a wind and built himself a water wheel and a wind engine. Here he was employing the *gravitational* force of molecules, the "lumber" out of which cells are made.

Next he observed the steam raising the lid of a tea-kettle, and straightway began to use the *expansive* force of molecules in the steam engine, greatly multiplying his power.

Observing that when certain substances are mixed together they explode, he began to utilize the *explosive* force of the molecule, which finds its highest use in the modern automobile.

Hints of another force began to trickle through his mind, and *electric* power came into being. We now know that this is a form of atomic excitement, in which streams of electrons shove one another through miles of wire.



Photograph from Mt. Wilson Observatory

A CORKSCREW METEOR TRAIL

When some meteors strike the earth's atmosphere they are of such irregular form that they "wabble" in the air like a poorly rifled high-explosive shell, only much more so.

But the radium atom tells the physicist and the astronomer that atoms explode just as molecules do, only with infinitely more power.

The fastest explosion the Du Ponts have ever been able to produce has been at the rate of about 7,700 yards a second. The radium atom, in its disintegration, hurls its fragments at the rate of 12,000 miles a second, nearly 3,000 times as fast as the fastest known molecular explosion.

The fall of the water at Niagara represents an energy equivalent to the burning of a ton of coal every second, yet the power slumbering within the atoms of a pitcher of water is as great as that produced by the descent of Niagara's waters for a full day.

GIVING THE ATOM THE "THIRD DEGREE"

Will the physicist, with his superpowered electric furnace, and the astronomer, with his flaming stars, working hand in hand, and often, as in the case of the Mt. Wilson Observatory, as a unit, be able to wrest the atom's secrets from it?

They appear to be pressing it closely. Out at the Pasadena laboratory of the Mt. Wilson Observatory last August, Dr. J. A. Anderson showed me an instrument of atomic inquisition that must, figuratively speaking, twist their tongues and burn the soles of their feet.

It is a great electric condenser, made up of 160 large glass plates, with a capacity of 100,000 volts, and capable of producing, even at 55,000 volts, a momentary discharge of the immense current of 40,000 amperes.

When he turned on the power he invited me to listen to the ghost within. And it certainly sounded like a ghost, pounding and pounding away, as if it were some furious monster in torture, trying to batter down the walls of its prison with a huge mallet. As the current was increased, the pounding became more frenzied.

Then Dr. Anderson laid a wire across the gap of the big transformer and turned on the current again. When the burden became too heavy, there was a flash and a crash, and where the wire had been there was nothing. The metal had exploded, and not a trace of it was left.

That was only a demonstration. When Dr. Anderson really wants to interrogate the atoms, he makes the explosion take place in a high vacuum, preparations for which require a week.

Photograph from Yerkes Observatory

AN ASTRONOMER GOING FROM HIS WORK AT YERKES OBSERVATORY

There is a standing rule that astronomers must stop work in the unheated dome of the big telescope when the thermometer reaches 25° below zero; but if the "seeing" is good the observers break the rule.

Watching such an atomic demonstration, one pauses to learn something about the atoms and why they produce all those lines in spectroscope and spectrographs.

These lines serve as probes with which to pry into the behavior and constitution of matter; become speedometers with which to gauge the flight of stars through space; act as thermometers with which to measure the temperature of remote stars; and, in divers other ways, reveal the mysteries of the universe.

Light, after all, is not what it seems to our eyes. While a filament in an electric light bulb appears to be glowing throughout, that is not what is actually happening. That filament is composed of billions of atoms, and each atom is a solar system with a central sun, known as a nucleus, and scores of attendant planets, known as electrons.

The simplest atomic solar system, the hydrogen atom, which has only one planet (electron), will serve better to illustrate what does happen than a complex atom like that of tungsten.

In the hydrogen atom the electron is constantly changing its orbit around its nucleus. Now it has an orbit corresponding, say, to that of the earth; suddenly it jumps the track and flies into another orbit corresponding to that of Mercury; then, perhaps, it hops out to an orbit similar to the orbit of Mars, Jupiter, or even Neptune.

The jumping of the electron from one

Iron, tungsten, lead, aluminum, calcium, and many other materials have been exploded. When they explode they write their record in a specially devised spectograph, which is able to take photographic cognizance of changes occurring in the millionth part of a single second.

THE USES TO WHICH ASTRONOMERS PUT LIGHT

Under such conditions the atoms reveal much of their composition. Those of calcium, for instance, disclose nearly 900 lines in their spectrum.

orbit to another creates waves in the ether, and the length of the waves depends on the length of the hops. The shortest jumps are apparently most frequent, and the longest most rare.

As the waves engendered by these hops come into the spectroscope, it classifies them, each class making its own particular line.

In this way each line in the spectrum of hydrogen is a summary of all the orbital hops of a given type occurring in the atoms from which the light comes. The frequent jumps make the clear lines and the rare ones give the faint lines.

Heat, magnetism, pressure, and other things affect the orbital behavior of the electrons. In the explosion of calcium with his giant transformer, Dr. Anderson got 800 new lines, showing that its electrons exhibited hundreds of new kinds of orbital behavior under the fierce punishment to which he subjected the calcium atoms.

A PROBE THAT SOLVES THE MYSTERY OF THE COMPOSITION OF STARS

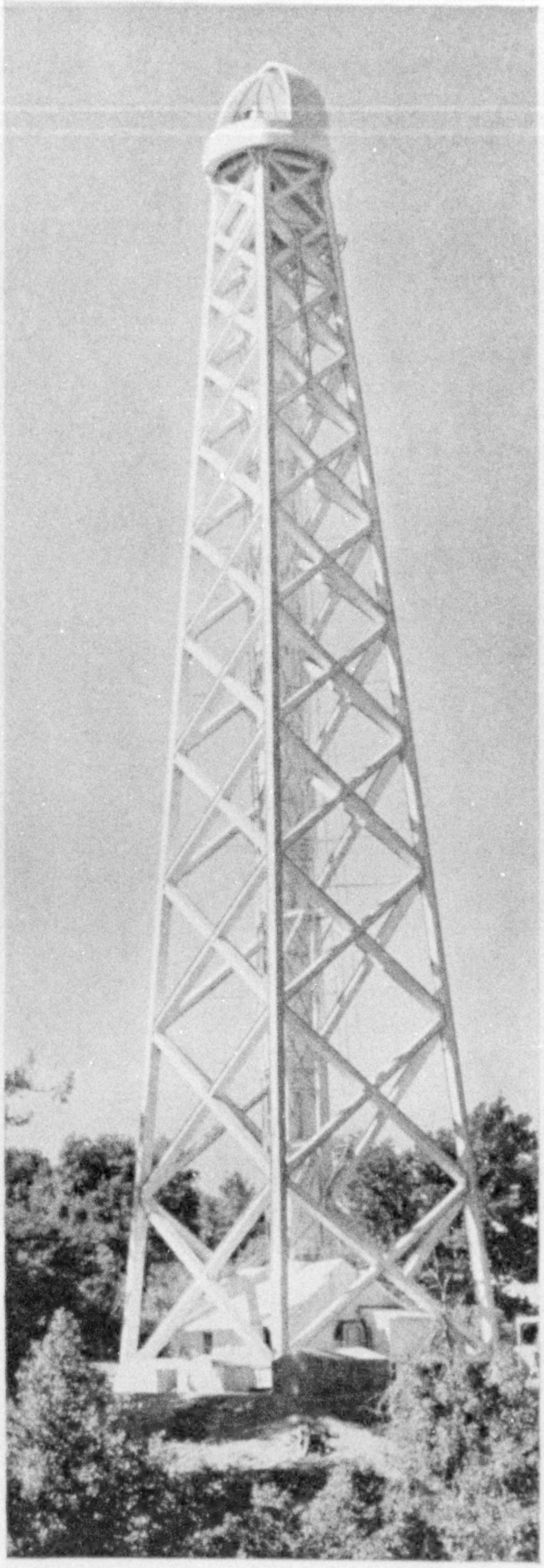
Having seen what causes the lines in the spectroscope, let us see how the astronomer makes use of them in interviewing the stars.

Every element has its own particular group of lines, and no bank cashier or United States Treasurer ever had a signature more certainly his own than each element writes in the spectroscope.

So when an astronomer finds a given set of lines in a star he knows that the element whose signature those lines constitute is found there. When a hitherto-unknown group of lines appears, he knows that a new element has been found, as in the case of helium.

Therefore, hitching his spectroscope to his telescope, the astronomer gets a Brobdingnagian probe with which he can reach out through the vast stretches of space and not only lay bare the materials of which the well-nigh infinitely remote stars and nebulæ are made, but even many of the conditions with which they are surrounded.

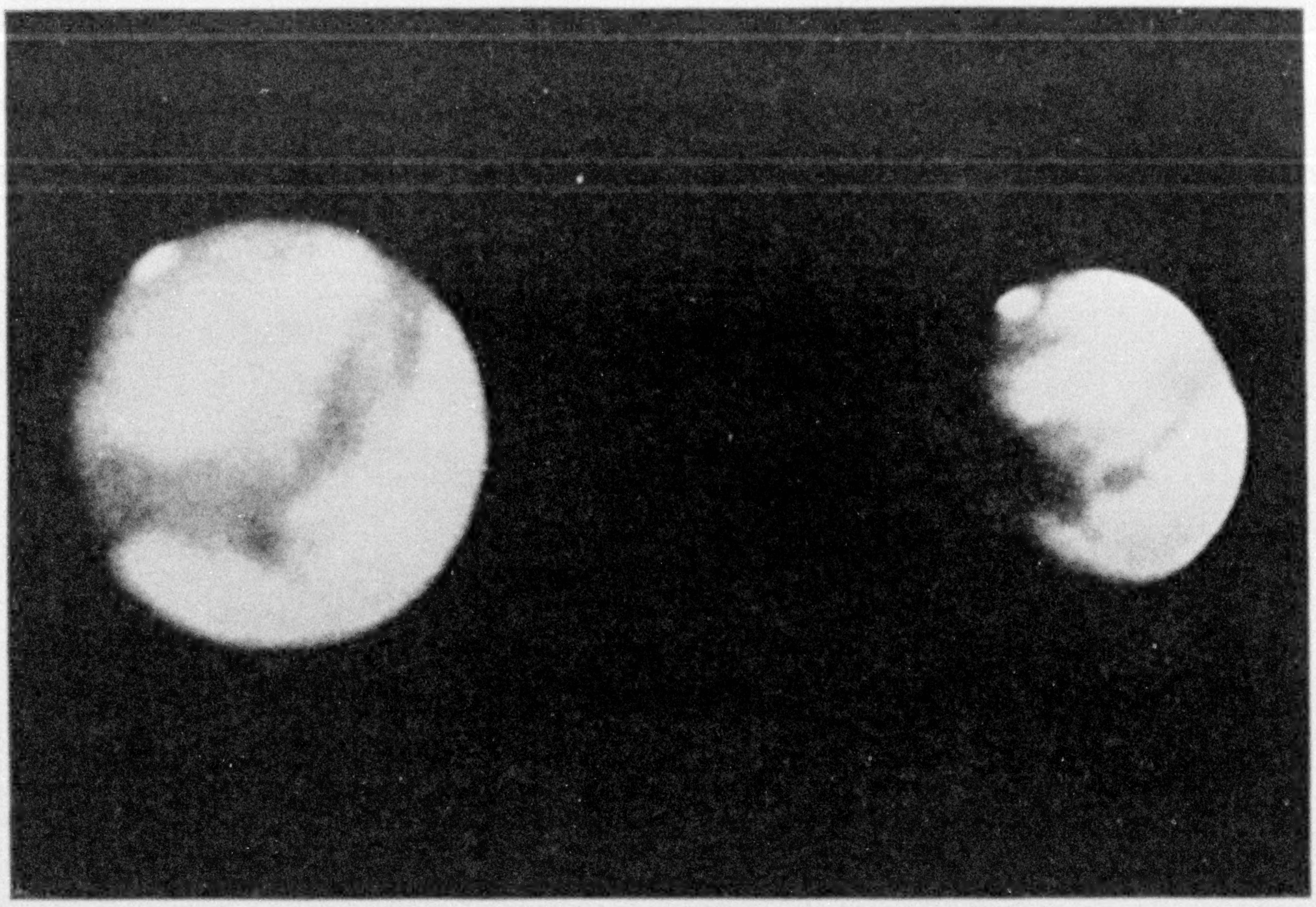
Everyone has noticed in traveling on a double-track railroad and passing a train running in the opposite direction that the pitch of the sound of the bell of the passing locomotive goes from high to low as the train changes from an approaching to



Photograph from Mt. Wilson Observatory

TOWER TELESCOPE USED AT MT. WILSON TO STUDY THE SUN

With this 150-foot tower and a 75-foot well beneath, the sunspots and the great flames, or prominences, on the edge of the sun are made to tell their story.



Photograph from Mt. Wilson Observatory

TWO VIEWS OF MARS SHOWING THE SOUTH POLAR CAP

These pictures, taken at Mt. Wilson a month apart, show different regions of the planet's surface. The polar ice advances in the Martian winter and retreats in summer, as on the earth (see text, page 121).

a receding position. And an expert in acoustics could tell the relative speed of the two trains from the amount of change in pitch; or, knowing the speed of his own train, he could tell the speed of the other.

THE COLOR OF LIGHT BECOMES A SPEEDOMETER

In the same way, when the light from a star moving toward us comes into the spectroscope, the lines in the spectrum crowd toward the end corresponding to the high pitch. When the light from a star moving away is studied, the lines move toward the end corresponding to low pitch. Furthermore, this shift of lines is in proportion to the velocity. Knowing the motion of the earth in space, it is a simple matter to calculate the velocity with which a star under observation is approaching or receding (see page 116).

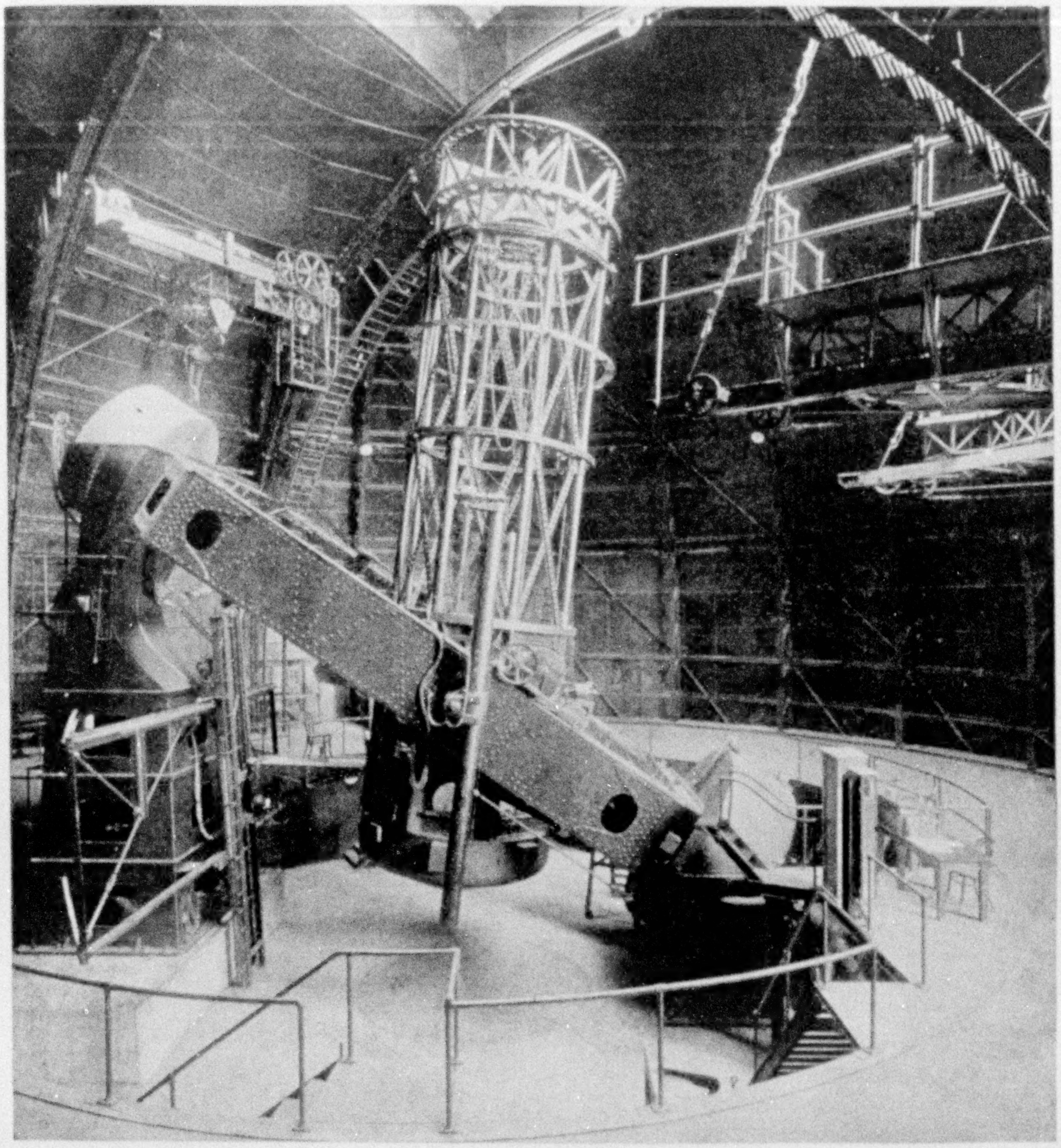
This does not mean that the star is coming head-on or moving straight away at that velocity.

It may, indeed, be traveling almost perpendicular to our line of sight. To illustrate this, suppose one could stand at New Orleans and watch an airplane fly from New York to Los Angeles. When it reaches Dayton, Ohio, it might be flying toward Los Angeles at a speed of 100 miles an hour, but getting closer to New Orleans, by only 10 or 20 miles an hour. The spectroscope could not measure the velocity of the airplane in its actual direction of flight, but only that portion of its motion which brings it closer to New Orleans.

WATCHING AN ASTRONOMER INTERVIEW A SPEED KING

It is a fascinating experience to "sit in" when an astronomer decides to convert his big telescope into a speedometer to measure the velocity with which one of the celestial speed kings is approaching us or retreating.

It may be so far away that, although it is flying across the line of the telescope's sight at the rate of 12,000 miles a minute, the most refined measurements of which the greatest observatory is capable will not reveal that it has moved out of its own tracks in a decade.



Photograph from Mt. Wilson Observatory

THE 100-INCH HOOKER TELESCOPE AT MT. WILSON OBSERVATORY

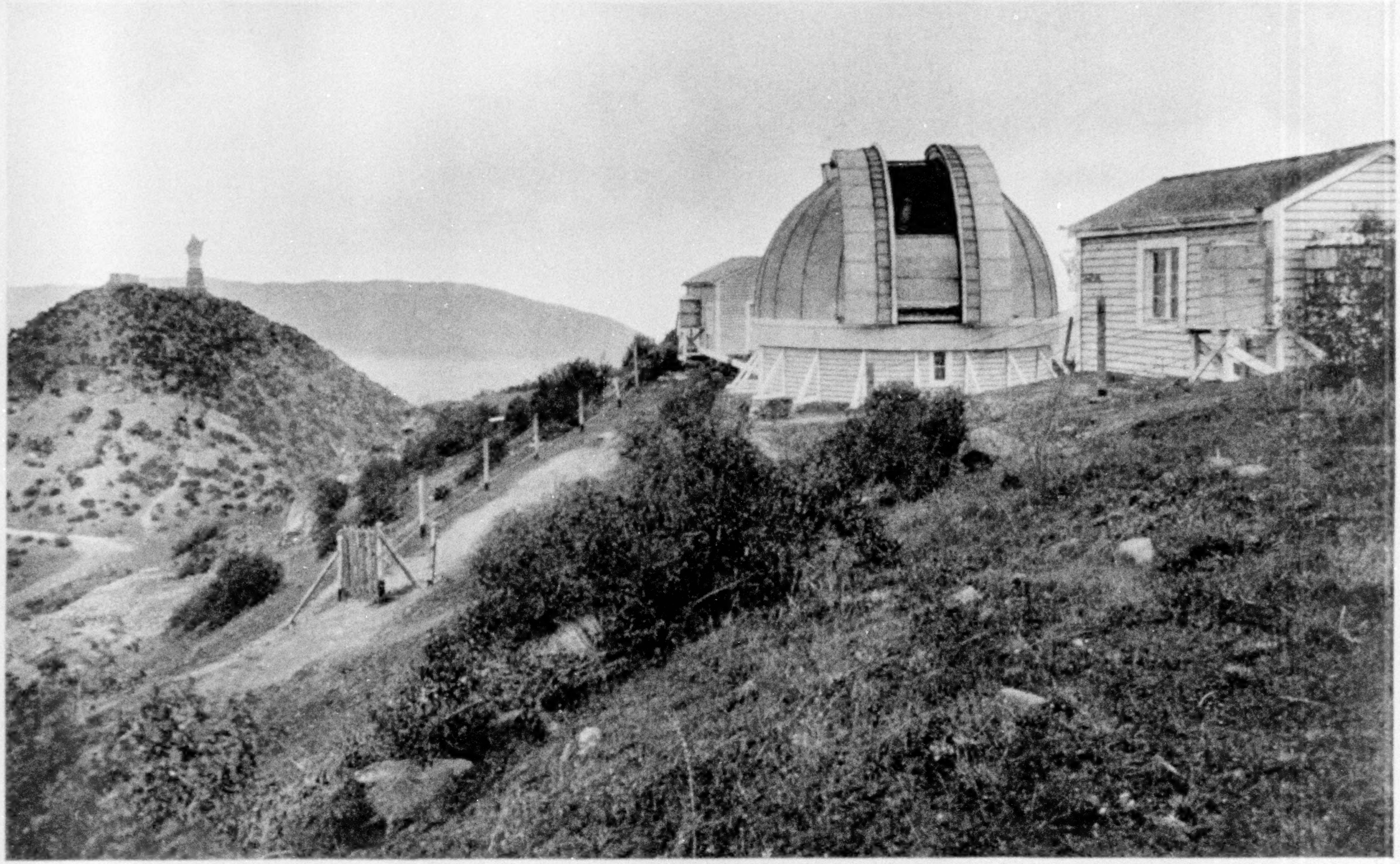
This reflector telescope has added half a billion stars to human ken. The movable parts weigh 100 tons, but the great instrument can be shifted and its position determined down to infinitesimally small fractions of an inch. The mirror that gathers the starlight and sends it to the eyepiece is at the lower end of the big structural steel barrel. The eyepiece is at the side, and may be placed near the top or bottom, depending on the type of work being done.

But if it is getting "hotter" or "colder," as the children would say in their blindfold games, the spectroscope will measure which, and by how much, in amazing fashion.

One Sunday night I sat with Dr. Sanford in the big Mt. Wilson dome while he and his assistant, with a spectroscope attached to the 100-inch telescope made a number of stars tell whether they were coming closer to us or going farther away.

One star in particular was difficult to interview. The first problem was to get it into the focus of the big telescope. It could not be seen with the naked eye, being so dim that even the 12-inch finding telescope, attached to the big one, could not pick it up.

Searching for it with the big mirror would have been like hunting for a needle in a haystack, for the more powerful a telescope the smaller the area of the



Photograph from Dr. W. W. Campbell

THE CHILE BRANCH OF THE LICK OBSERVATORY, UNIVERSITY OF CALIFORNIA, ON CERRO SAN CRISTOBAL, SANTIAGO, CHILE

The altitude of the observatory above the city of Santiago is 920 feet; above sea level, 2,755 feet. The camera is pointing south-southwest and a part of the city is faintly visible in the notch to the left of the dome. On the summit of the slightly lower peak, in the left foreground, is a heroic and massive statue of the Virgin, to which the people of Chile make pilgrimages in great numbers, especially on feast days. Through two decades this branch of the Lick Observatory has been measuring the motions of approach and recession of the naked-eye stars and of the bright-line nebulæ in the southern two-fifths of the sky. It was the pioneer in this field of research in the Southern Hemisphere.

heavens its field reveals, and a 100-inch instrument sees only a small spot at a time.

FINDING A CELESTIAL TRAVELER

So they found another star, of sufficient magnitude to be seen in the 12-inch finding telescope, that was very close to the one Dr. Sanford was seeking to locate. When the great 100-ton instrument was swung around so as to bring this star on the cross wires of the finder, the pressing of one button here and of another there made slight adjustments in the position of the big instrument until the star to be interviewed as to its observance of the celestial speed laws came into the slit of the spectroscope.

Then the photographic plate was put in. It was no bigger than the palm of a man's hand, and the part of it to be used was much smaller. A button was pressed, an arc light of titanium momentarily appeared, and what is known as the comparison spectrum was photographed on its section of the plate.

Then for two and a half hours we sat there, with an astronomer's eye always glued to the eyepiece.

The top of Mt. Wilson was every moment pointing to a new set of stars, for we were on the rim of the earth, traveling around its axis at the rate of a mile every three and two-fifths seconds to keep our engagement with the morrow's sun on the eastern horizon. But down in a big pier was a huge clock that turned the 100-ton telescope west at the identical rate that the earth's surface moved east, so that it always pointed to that star.

As the minutes rolled by, the temperature would fluctuate a little, the refraction of the air would change slightly, and a few other things that escape every unaided human sense would take place, any one of which would move the star out of its slit in the spectroscope.

But the pressing of one button here and of another there would bring it back. Thus the traffic officers of the observatory quizzed the speed king that was quadrillions of miles away.

When the interview was over, the star had admitted it was "hitting up a pace" that was bringing it 128 miles closer to us every second.

One of the greatest triumphs of modern astronomy has been the discovery, by Dr. Walter S. Adams and his associates at Mt. Wilson Observatory, of spectroscopic methods of fixing the distances of stars. The behavior of electrons in atoms under high pressures and low temperatures and under high temperatures and low pressures causes them to write peculiar lines on the photographic plates of the spectroscope.

Laboratory experiments have revealed the secrets of these lines and the astronomer from their character is able to fix the absolute brightness of almost any star that can register its light in the big telescope. Knowing the absolute brightness and the apparent brightness of a given star, the difference between the two gives the astronomer the data upon which he can compute its distance.

The late Miss Leavitt, of Harvard Observatory, worked out another method of fixing the absolute brightness of certain types of stars in the Small Magellanic Cloud, and her results corroborate the Adams method.

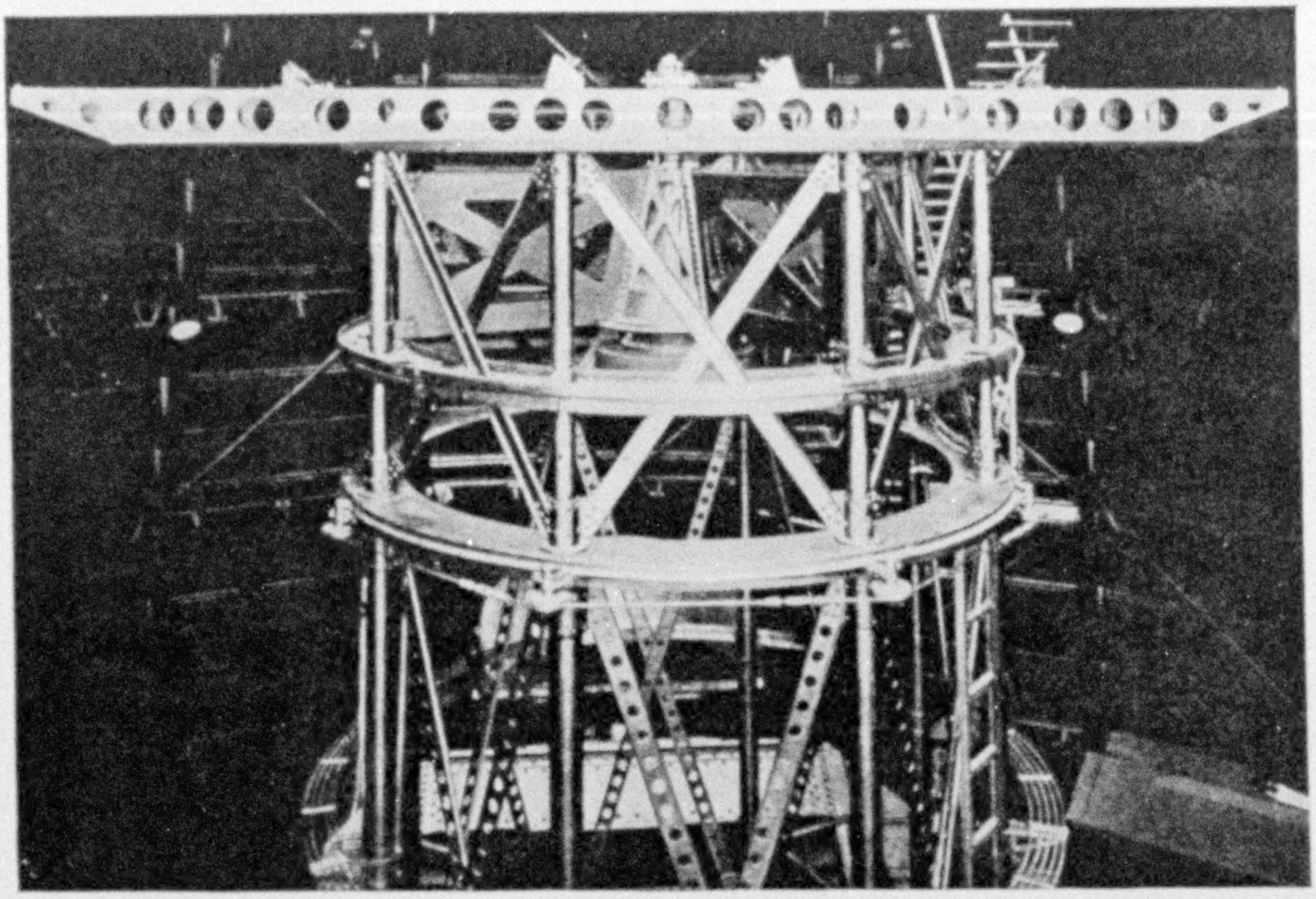
ETHER WAVES TRAVELING ELEVEN MILLION MILES A MINUTE, BRING IMPORTANT NEWS

Long before the first Pharaoh had appeared in Egypt or the Chaldeans or Babylonians had built their first zikkurat, the electrons of a group of atoms in a given star jumped from one orbit to another. In doing so they created a series of ether waves.

These waves swept out into space, hurtling on and on at the tremendous gait of more than eleven million miles a minute, and are just now arriving in the big spectroscope at Mt. Wilson, not only with a message of conditions in the star from which they started at the time they left, but also with a record of the distance they traveled to bring the news.

In fixing stellar distances by the study of spectral lines and light variations, it was necessary to know, by other means, the distances of certain key stars. An explanation of how this has been and is being done is in order.

When a civil engineer wants to find the distance of an inaccessible point, he measures a base line of sufficient length, and from the two ends runs lines with his transit to the point whose distance he wants to determine.



Photograph from Mt. Wilson Observatory

THE 20-FOOT INTERFEROMETER ATTACHED TO THE 100-INCH MT. WILSON TELESCOPE

This is the instrument with which the diameters of Betelgeuse (215,000,000 miles), Arcturus (21,000,000 miles), and Antares (400,000,000 miles) were measured. Two small mirrors on the upper edge and near the ends of the beam gathered the two pencils of light whose "interference" with one another was made to tell the story of the stars' diameters.

Thus he gets a triangle the length of whose base he knows, and the angles the two remaining sides form with the base line. The rest is a high-school problem in mathematics.

In the determination of the distance of the moon, a base line from a given point in America to another given point in France was of sufficient length, and in the measurement of distances of the closer planets the diameter of the earth represented the base line.

But when it comes to finding a base line which will give any appreciable angle in the measurement of star distances, no terrestrial distance will suffice.

GETTING A LINE ON STELLAR NEIGHBORS

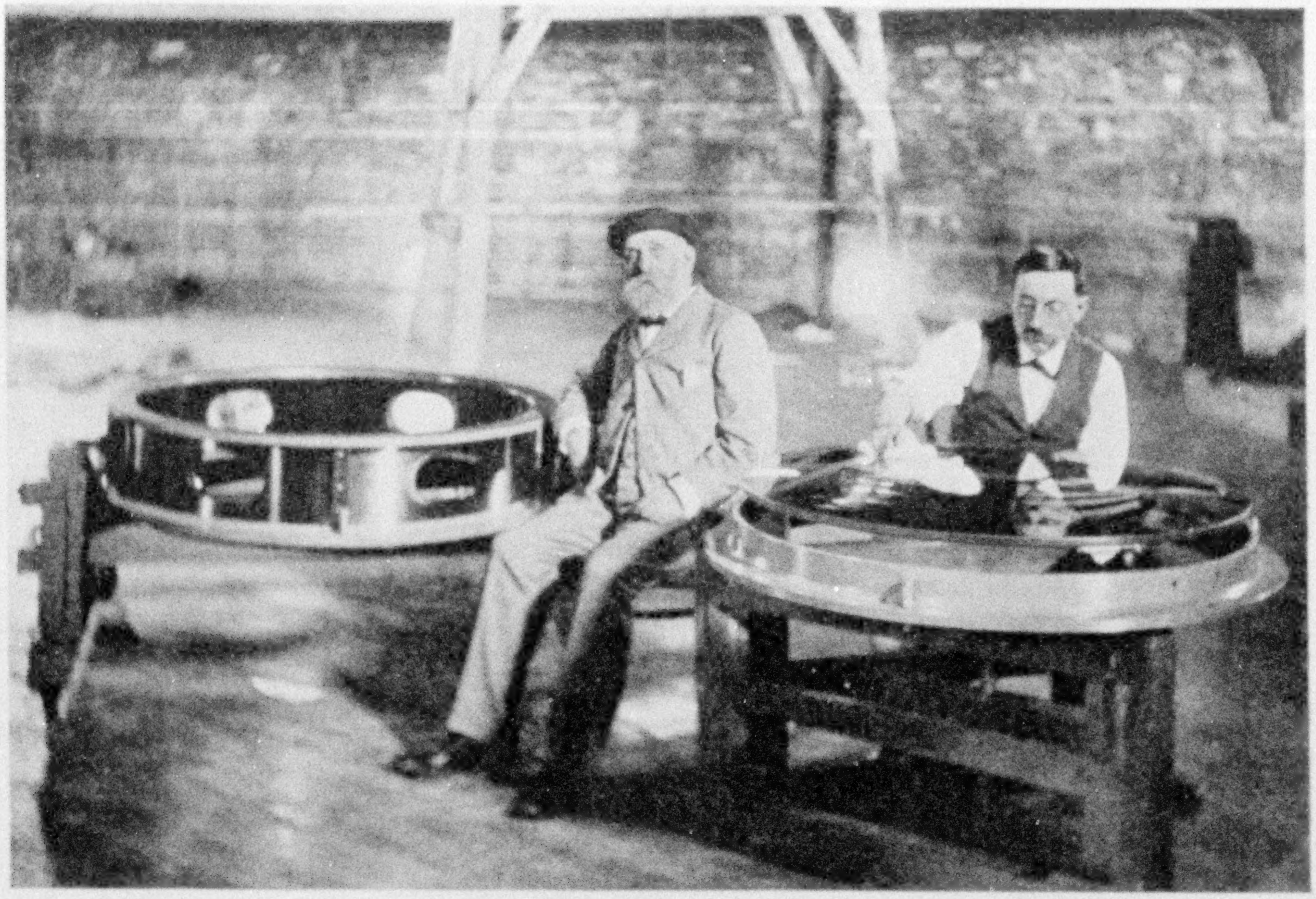
After patiently groping for such a base line, the diameter of the earth's orbit was taken. A star was viewed from one side of the orbit and the angle for the one side of the triangle measured. Six months later it was viewed from the other side of the orbit, and the angle for the other line arrived at.

Imagine constructing a triangle with a base one inch long and two sides eight miles long, and then measuring the angles at which the two sides depart from the base!

That was the sort of problem Bessel had when, in 1838, he measured the distance of the first star so studied, although his base line was 186,000,000 miles long (the diameter of the orbit of the earth around the sun). It took years for him to make the calculations by which the distance of 61 Cygni, in the constellation of the Swan, was fixed at forty trillion miles.

So laborious did such work prove that the distances of only 60 stars had been fixed up to 1900.

After that the Yerkes Observatory undertook to fix the distances of other close stars by photographic methods. Hold your pencil in an upright position before your eyes, about eight inches away, and then look at a picture on the wall ahead of you. Note the change of position of the pencil with reference to the distant picture when



Photograph from Yerkes Observatory

THE LATE ALVAN CLARK, OF CAMBRIDGE, MASSACHUSETTS, AND HIS GREATEST TELESCOPE LENS

Mr. Clark is seen at the left, with the 40-inch Yerkes refractor lens, the largest ever built. It was he who, with the lens he had made for the Dearborn telescope, was able to show that Sirius is a double star, thus proving Bessel's famous prediction. A refractor telescope uses a lens through which the light of the star passes on its way to the eyepiece. In those instruments having concave mirrors the light is reflected from the mirror to the eyepiece, which may be either at the top or the side of the telescope. The Yerkes refractor is the world's largest instrument of that type, and the 100-inch Mt. Wilson reflector (see illustration, page 109) is the largest of the mirror type.

viewed first from one eye and then the other.

Now, if you can imagine the picture on the wall as an infinitely remote star, the pencil as a comparatively near one, and the diameter of the earth's orbit as the distance between the pupils of your two eyes, you will see that photographs taken six months apart will show that the closer star has moved on the plate with reference to the remote one.

By the measurement of this displacement the distances of stars up to 373 trillion miles have been calculated.

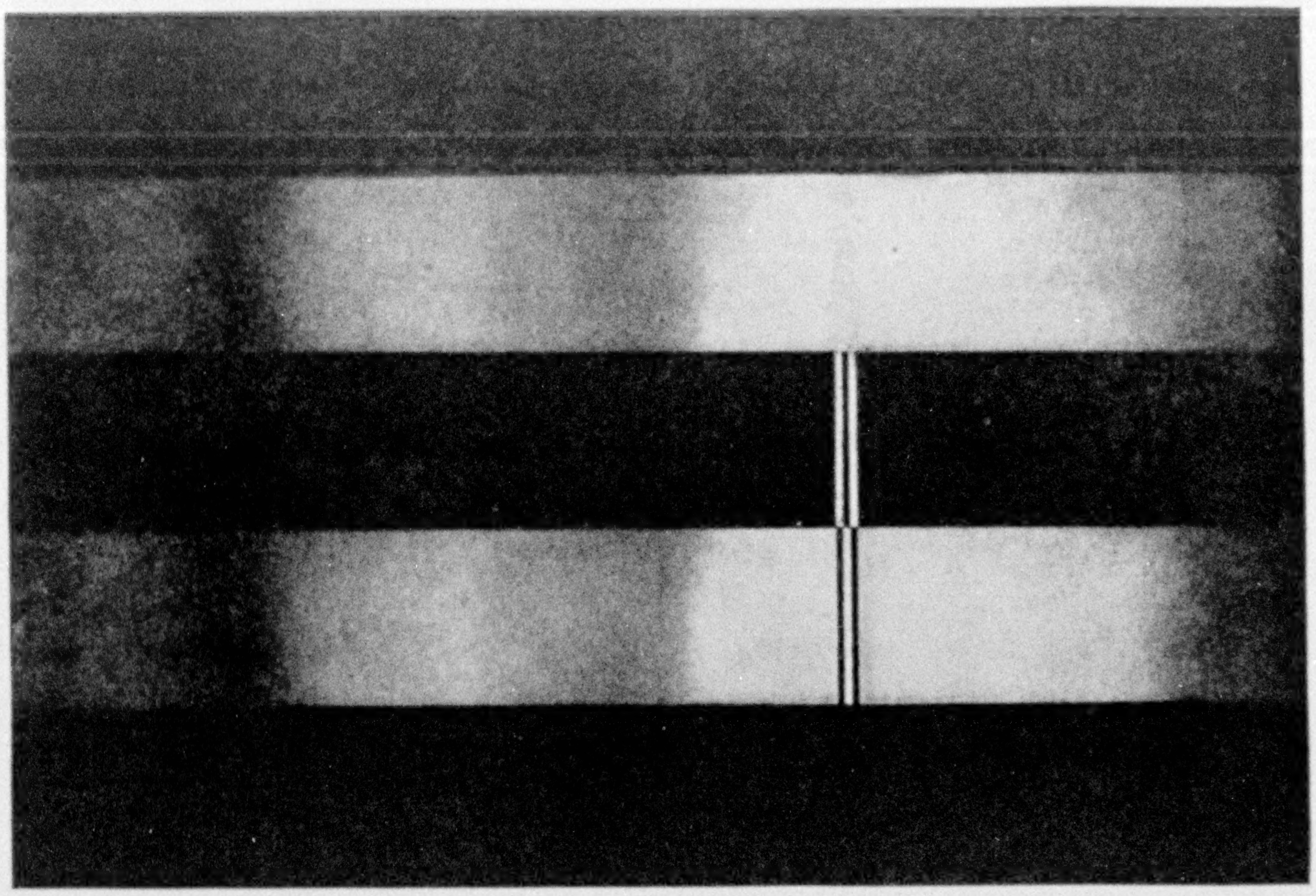
There are, however, distances to be measured for which even this method proves utterly inadequate, but for which new base lines have been found.

The sun and his family are driving through space toward Vega at the rate of 12 miles a second. In twenty years this flight gives a base line 40 times as long as the diameter of the earth's orbit, and the change of position of relatively near stars as compared with vastly remote ones is correspondingly larger.

It is a thrilling privilege to sit down with an astronomer and watch him measure these distances on his photographic plates. With a machine he calls a comparator he can measure distances down to 1/250,000 of an inch.

THE FLYING MINUTES FIXED FOR AGES

The photographic plate is an invaluable ally of the astronomer. It can see what the eye has never been able to behold. The eye becomes tired of looking and looking, and the fainter stars can never register on the human retina, even with the greatest telescope. But the light effect of one of these stars on the grains of sensitive silver on the plate is cumulative, and for hours and hours the light



Photograph from Mt. Wilson Observatory

THE THREE GREAT TYPES OF SPECTRA THROUGH WHICH THE STARS TELL THEIR STORIES

When light comes into a spectroscope from a solid body glowing with white heat, it presents the ordinary prismatic colors of the rainbow. When the light comes from glowing gas, instead of from a solid, it gives a black band crossed by bright lines as shown in the middle band of the picture. But when it comes from a solid glowing body and passes through a cooler gas, like the atmosphere of the sun, it gives a prismatic band, but crossed by dark lines, as in the lower part of the picture (see text, page 106).

of a given star may be held on a definite spot on the plate, building up its image to a perceivable magnitude.

On the plate the flying minute is fixed forever, and at will the bit of sky it covers may be revived, although generations may have passed since the photograph was taken.

Appreciating the value of a vast directory of the stars which would show their relative positions on given dates, eighteen great observatories in all parts of the world undertook to make such a directory of all stars down to the eleventh magnitude. The record has been finished and contains some six million stars.

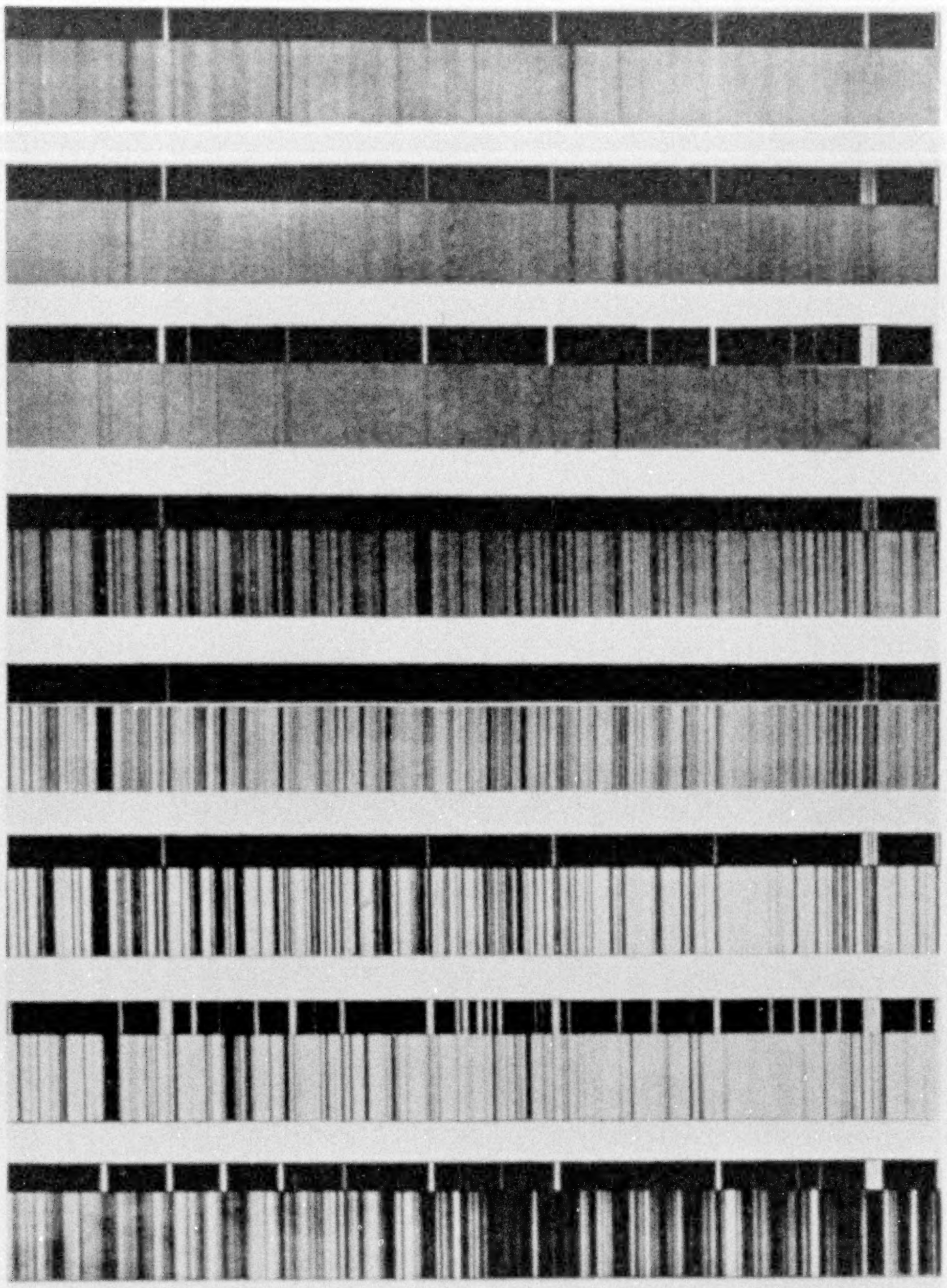
Imagine the inestimable value of these plates a thousand years from now, if they can be made to endure. Compared with similar plates taken then, they would reveal the changes in the celestial map in ten centuries. Nothing could serve better to clear up the mysteries of the universe than such a comparison.

Yerkes and other observatories feel that there should be established an adequate depot where these vastly important records can be stored under conditions that will protect them against the menaces of fire, tornado, earthquakes, and other cataclysms for a thousand years, and are looking for the far-visioned man who, by endowing their care, would transmit these invaluable records to the people living a millennium hence.

THE STORIES THE CENTURIES WILL TELL

Nordmann, after speaking of some of the marvelous things that the studies of the stars have revealed, says that all these results are nothing in comparison with those which the generations that come after us will discover, as from century to century they rephotograph these stars and compare their plates with ours.

Projecting upon a screen the negatives made to-day and those made in the centuries that follow, he says that the student will be able to review in a few moments the age-long history of the universe, with its vicissitudes, in which some stars have been born, others have grown to maturity, others have passed down the hill, and still others have joined the mute and silent and lightless procession that passes behind the coffin of Time.



Photograph from Yerkes Observatory

CODE MESSAGES FROM EIGHT FAMILIAR STARS

These messages are brought on the wings of light and placed on photographic paper by means of the spectroscope. Above each broad band is a narrow black one. These are the keys by which the astronomer translates the message. From top to bottom, the messages are from Mirzam, Rigel, Sirius, Mirfak Sun, Arcturus, Aldebaran, and Betelgeuse.

THE WINGS OF LIGHT

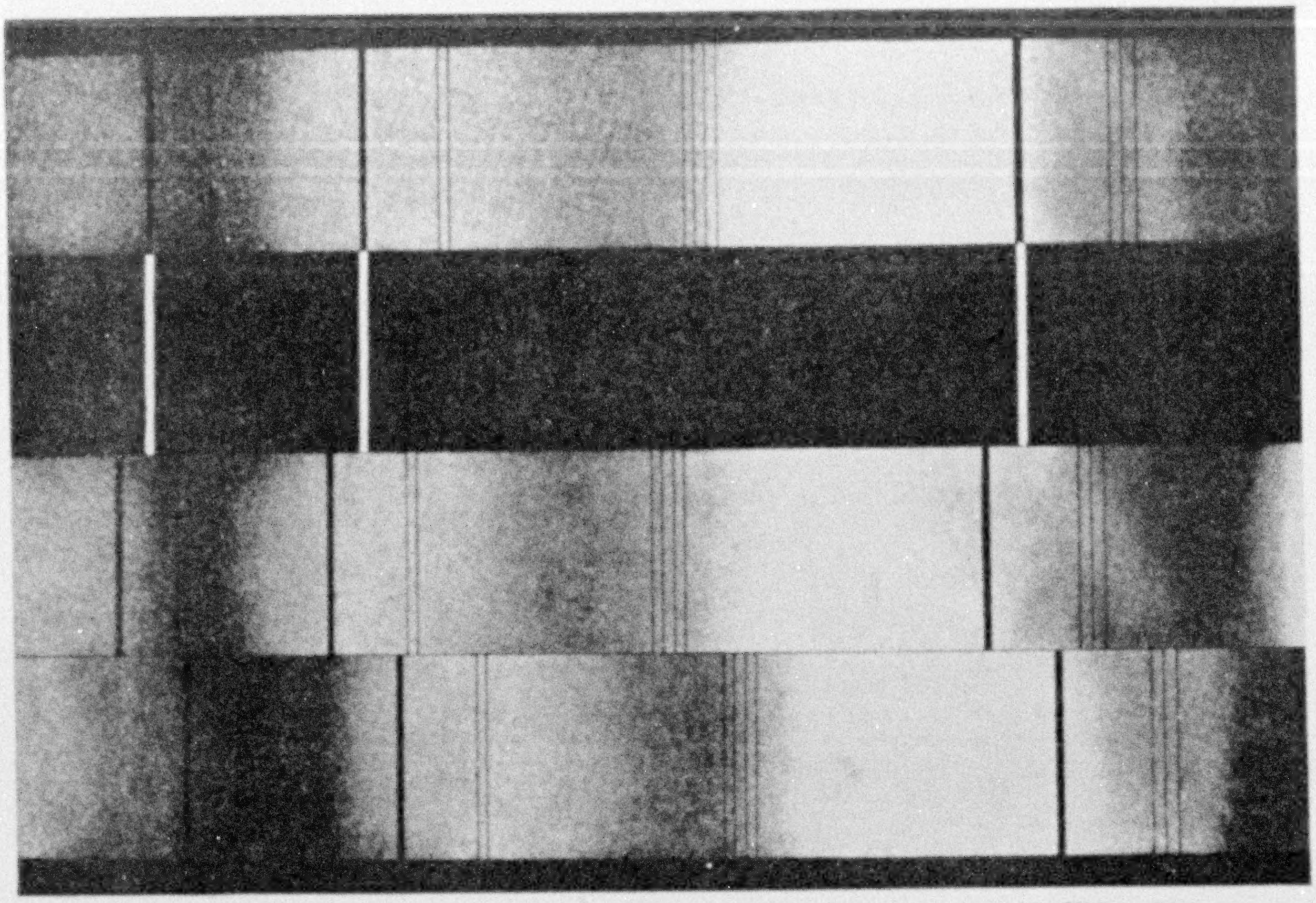
One who has seen the infinite pains to which the astronomer has gone to measure the distances of space gets a better comprehension of the scale of the universe.

If we could travel out through space in a series of journeys on the wings of a light wave, we could get a lively appreciation of the span of the heavens. We could go to the moon in a single second; to the sun in about eight minutes; to Neptune in a little more than four hours.

If we wanted to visit our closest star neighbor, Proxima Centauri, which, under measurements made at Cape Town, has recently supplanted Alpha Centauri as the nearest known fixed star, we would have to prepare for a nonstop flight of four years. To visit Sirius would take over eight years on the outward voyage, and, having arrived, we would find the Dog Star 33 times as bright as our own sun.

To go to Altair we would have to make a flight lasting 15 years, although our speedometer were registering more than 11,000,000 miles a minute. We would find the running time to Vega and Arcturus about 30 years, and when we got there would discover that they were each 80 times as bright as our own sun.

To reach Capella we would have to make a nonstop flight of 47 years' duration, and on arrival would find it to be two stars instead of one, each 100 times as bright as our sun.



Photograph from Mt. Wilson Observatory

SPEED RECORDS WRITTEN BY THE STARS

The second, or black band with the white lines, is the laboratory-made comparison spectrum. The joining of the black lines in the top band with the white ones shows that the star that told its story in the top band was traveling in a direction that keeps it a uniform distance from us. The lines in the third band, displaced toward the left from those in the second, say the star which wrote the record is receding from us and gives its velocity of recession. The lines in the fourth band, displaced to the right of those in the comparison bright lines, proclaim that the star which wrote them is coming toward us and tell the astronomer how fast it is coming (see text, page 108).

If our fancy turned us to the Pleiades, we would have to fly more than 11,000,000 miles a minute for 325 years. Arriving there we would find them to be a group of from 300 to 500 stars, filling a niche in space about 180 trillion miles in diameter.

And then, if we wanted to visit that marvelous star in Orion which we call Rigel, we would have to outfit ourselves for a journey that would last 500 years. Arriving at Rigel we assuredly couldn't land, for it is 13,000 times as bright as our sun.

THE DISTANCES OF THE SUNBURSTS OF THE SKY

It would seem that any star that was 500 light years away, when the solar system is only a little more than eight light hours in diameter, ought to be near the limit of things finite.

But great as are these distances, they are short journeys compared with some we could take.

For instance, there are the star clusters, those wonderful sunbursts of the heavens that reveal themselves in such striking beauty in a high-power telescope.

The fine cluster in Hercules, estimated to contain a million stars, has some 35,000 that are from 1 to 1,000 times as bright as our sun. If we wanted to visit that cluster we would have to equip ourselves for an outward light-speed journey of 36,000 years. The globular cluster known as Messier 79 is 85,000 light years away. It has been likened to a silent and crowded swarm of gleaming celestial bees.

The spectroscope tells the astronomer that the Hercules cluster is approaching 195 miles nearer to us every second. A swarm of stars with a total mass equal to 100,000 of our suns, moving hither

and yon among themselves, and yet possessing a swarm velocity of 195 miles a second! No wonder the brain staggers when trying to get a conception of the universe!

But if the full picture is drawn, we must realize that clusters have been found which are 200,000 light years away; yet so definite is the law of the conservation of energy that, even after traveling through all these two thousand centuries, the wave messengers from these inconceivably remote clusters are still able to deliver to the astronomers their reports of conditions existing in those clusters when they started on their journey (see illustration, page 115).

ARE THERE OTHER UNIVERSES LIKE OUR OWN?

But at what some distinguished authorities believe a still greater distance, float a million spiral nebulæ.

If the conclusions which the evidence is forcing astronomers to reach are warranted, they lie at distances which range from 500,000 to 10,000,000 light years away from us and appear to be other "universes" like our own, yet so distant that their stars cease to be separately discernible in the most powerful telescopes.

To these instruments they appear as small and vapory spots "formed by two spirals rolled together, like silvery snails exhibited in the garden of stars."

The grounds on which they are believed to be systems like our own galaxy, with their own Milky Ways and star clusters, their own constellations and suns, their own planets and satellites, are numerous.

When their light is analyzed in the spectroscope, it does not give the lines of gaseous material, but rather lines that might be expected from stars so remote that we can get only the glow of the group and not their individual light.

Still further, all the *novæ*—stars that suddenly flare up and then wane—occurring in that part of space which clearly belongs to our universe occur in our Milky Way. They all attain the same maximum brightness.

It has been found that these novæ also occur in the spiral nebulæ, and that their behavior and course are identical with the novæ of our own Milky Way.

Several years ago a great debate was held under the auspices of the National Academy of Sciences, in the National Museum, in Washington, between two leading astronomers, representing two schools of thought, as to the significance of the spiral nebulæ, the one school urging the conception that they were "island universes," and the other arguing that they were parts of our own system.

But the discovery of novæ in them has since converted some who challenged the "island universe" idea, and it has just been announced that Dr. Adams, at Mt. Wilson, has secured definite proof that spiral nebulæ are indeed isolated systems, perchance as great as our own, each separated from its neighbors by vast oceans of untenanted void, and each possessing its billions of stars, even as our own.

When dinosaurs roamed the earth the light waves that proclaim their existence had already started on their inconceivably long journey to the telescopes of the astronomers of to-day.

STAR DUST BECOMES COSMIC CLOUDS

These fleeting glimpses at other "universes" than our own will perhaps the better prepare us for some further wanderings while we explore the stuff of which stars are made.

In many sections of the sky are found black spots and hazy wisps of light that are readily differentiated from the spiral nebulæ, both as to distance and constitution.

For years these "coalsacks," "holes in the heavens," and "glowing clouds" mystified the astronomers, but recently even they have been forced to submit to interviews that have led to some startling admissions.

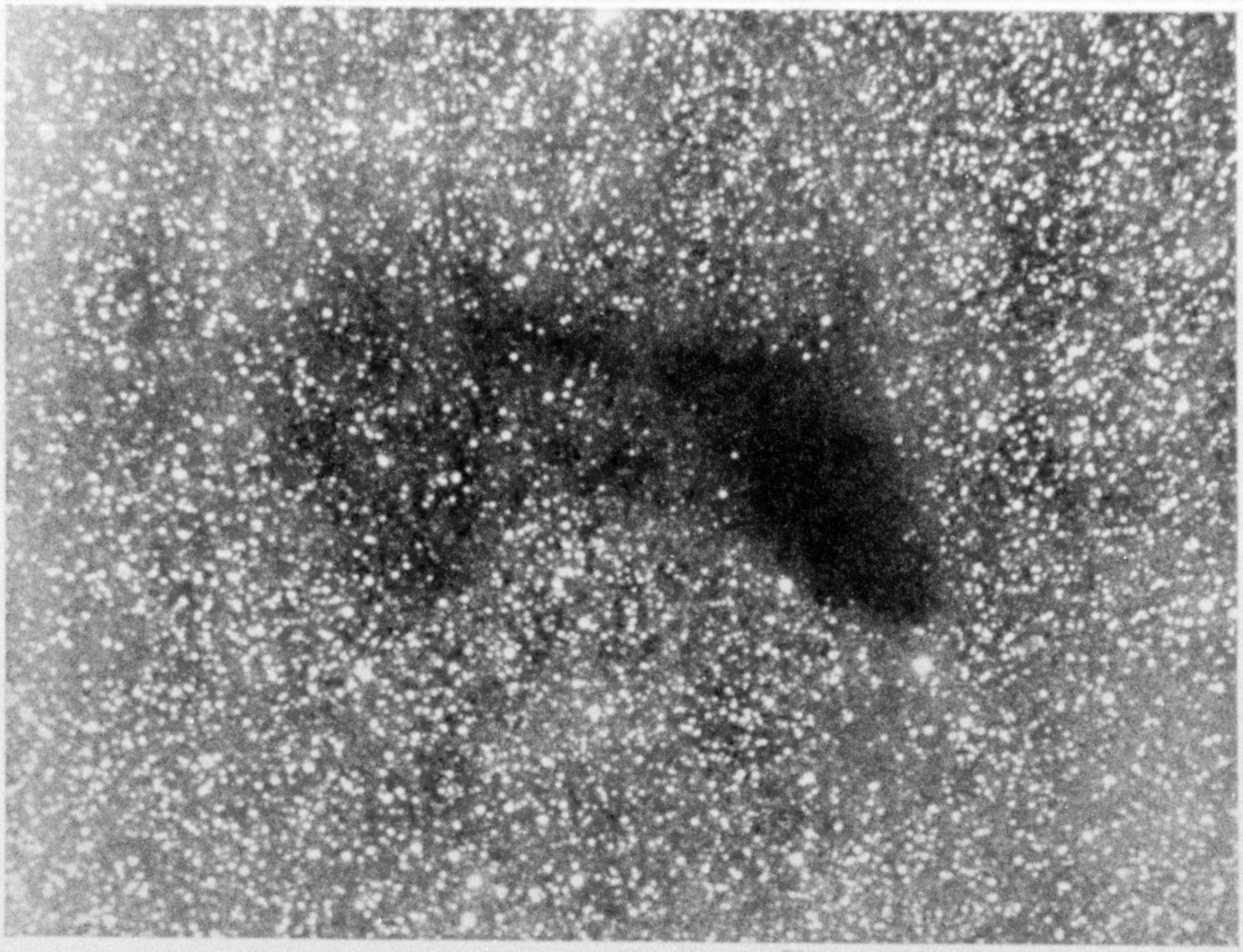
It has been found that light, whose pressure on earth is so feeble as largely to escape notice—unless we look at those little multivaned radiometers turning in their vacuum cases when the sun is shining in an optical-goods show-window—exerts a tremendous pressure in the hotter stars.

Even in the sun this pressure amounts to ten times the gravitational pull on tiny particles of dust of certain densities, and in the hotter stars it may be ten times as great.

Photograph from Mt. Wilson Observatory

LIGHT AND DARK NEBULÆ IN THE CONSTELLATION OF ORION

In the upper left corner is the bright nebula in the sword handle of Orion, and in the center of the picture the head of the huge obscuring mass that blots out every star shining behind it, just as our own clouds at times shut out the light of the moon and the stars at night. These types of nebulæ are regarded as immense clouds of dust driven by the pressure of light into empty space, and finally, under the forces of gravitation, condensed into great stars like Antares (see text, pages 117 and 119).



Photograph from Mt. Wilson Observatory

A DARK NEBULA IN AQUILA

The spiral nebulæ have been found to be traveling away from or toward us at the rate of 500 to 600 miles per second. Light that comes into the telescope from them to-day brings us records of what was happening in them when dinosaurs were roaming the earth. Thus does the Past live in the Present and project itself into the Future in the field of astronomy.

So that every bright star exudes oceans of cosmic dust particles and inconceivable numbers of free electrons, which, pursued through space with the whiplash of driving light, must move on and on, forever seeking company and finding it.

CELESTIAL CLOUDS WITH "SILVER LININGS"

Finally great clouds of this cosmic dust form. If these vast clouds occur in regions remote from stars they are dark and forbidding, the "coalsacks" of the heavens; but if they chance to form in regions peopled by stars, they become cosmic clouds with "silver linings." In some cases the spectroscope reports that the light is merely reflected star light, while in other cases the star light clearly arouses within the dust a glow of its own.

"Star dust" has long been a figure of speech, but now it has come to have a literal as well as a figurative meaning.

Nordmann, the eminent French astronomer, offers the climax to the story. These huge, shapeless nebulæ form "the breeding ground where stars are born."

The theory generally held as to how stars come into being is that the accumulating clouds of cosmic dust become so heavy that gravitation begins to draw together the particles that constitute them.

As the process goes on, the flying molecules begin to collide with one another. These collisions stir the electrons in their atomic orbits, and heat is generated, with the result that the mass begins to glow—now red, now yellow, now white, and now blue—as contraction goes on and temperature rises.

It has now reached the limit of contraction, and we have a star of the Rigel type, 13,000 times as bright as our sun. The star is in its prime. The vast pressures and terrific temperatures resolve all matter to its simplest form. No complex atom like that of iron could hold together amid such frenzied surroundings any

Photograph from Mt. Wilson Observatory

AN EDGE-ON VIEW OF A SPIRAL NEBULA IN VIRGO

The majority of astronomical opinion has come around to the idea that the spiral nebulæ are "island universes" so far removed from our own stellar system that no telescope can separate the light of the stars that compose them. Their messages through the spectroscope indicate that their light is starlight, and the million of them that have been found seem, without exception, to have the watchcase shape that characterizes our own stellar system (see text, page 117).

more than an ice crystal could defy a blowpipe, or a nitroglycerin molecule resist an electric spark.

So here hydrogen and helium are the dominant elements.

DOWN THE HILL IN STAR LIFE

Then cooling begins. The star has passed the top of the hill of its life. As the millions of years, that are but the ticks of a clock in its life span, roll on, the journey toward the grave begins. Again a white star, but now a dwarf, the temperature is falling, and the hydrogen and helium are condensing into more complex elements. Still further cooling, it becomes a yellow dwarf, like our own sun. Here the temperatures become low enough to permit the formation of more complex elements and even compounds.

Other millions of years pass, and the star that began its career as a red giant becomes a red dwarf. It is on the borderland of death. Presently, remembering that millions of years are but moments in star existence, the red glow ceases and the dying star passes out into the realm of things unseen.

How many of them must there be floating around as lightless derelicts in the oceans of space! How many hundreds of human beings are dead for every person that lives! And yet the life of a star, long as it is, is probably not longer in proportion to the life of the heavens than is the life of the individual in proportion to that of the race!

The earth and the moon, though different in their origin, typify the end of every star—cooling until the crust forms, the only light it can now give being such as it borrows and reflects from some other star.

THE PROBABLE LIFE HISTORY OF OUR SUN

It is believed that in its youth our sun was, perhaps, as large as Antares, and as

red, and that it may even have filled the space within the orbit of Neptune.

The matter composing it at that time may have been even more attenuated than the air in the vacuum tubes of a modern radio set. But as the ages went by, these particles came closer and closer together, the temperature rose higher and higher, and the hue changed progressively until it reached the blue-white of a Rigel, 13,000 times as bright as it is now.

Then it began to cool, a process that has covered eras that make centuries seem no longer than seconds appear to us.

Finally there swept past the region it occupied some wandering star. It may have passed millions of miles away, but at that it came close enough to stir vast tides on the surface of the boiling sun, even as the pull of the moon raises tides upon the seas of the earth.

Finally the tide rose so high that a vast elongated drop of the molten material was pulled away—a drop with a fair-sized head, a huge waist, and a small tail, like a drop of water starting from the lip of a faucet.

This great drop of molten material became the planets, subdividing so that the tip of the tail became Mercury, the waist Jupiter, and the head Neptune, the other planets getting their appropriate positions.

As the passing star moved on, it imparted to the drop thus pulled away and subdivided a swing in orbits that the planets now possess. And so the sun that was became the solar system that is.

MARS AND ITS SECRETS

What of these planets to-day? Is Mars inhabited? Are there canals on its surface? Do other stars have planetary systems like our own?

When Mars came closest to the earth last summer I was visiting some of America's leading observatories. While the people were intensely interested in what this approach would disclose, the astronomers, with few exceptions, were much less so, for they knew that in 1924 Mars crossed the heavens far south of the zenith. To look at it with a telescope then meant the viewing of it through a much greater depth of atmosphere than would be encountered with the planet crossing near the zenith.

Two years hence Mars will cross the sky at a much higher elevation from the southern horizon, and what will be gained by increased visibility will more than compensate for what is lost by increased distance.

Mars is the most observable of the planets. Venus hides herself in clouds that prevent a good look at her surface; but the atmosphere of Mars is less dense, so that the man at the eyepiece of the telescope can see the planet's surface with clearness and distinguish various geographical features. Among these might be mentioned the polar caps, which have a way of advancing in the Martian winter and retreating in summer (see page 108).

ARE THERE CANALS ON MARS?

A recent series of photographs of Mars, taken by W. H. Wright, at Lick Observatory, with infra-red and ultra violet light, give evidence that the planet has a denser atmosphere, however, than was hitherto suspected, and this may scatter and absorb visible light in much the same way as the earth's atmosphere. Even the "polar caps" seen through the telescope with visible light may be, according to Mr. Wright's conclusions, clouds or banks of haze overlying solid caps of smaller dimensions on the surface of the planet.

Besides these caps, there are certain features that look not unlike continents, one even reminding the observer of the projection of India from the continent of Asia.

With reference to the "canals" that some observers have believed they could see, it is to be said that none of the larger telescopes have ever revealed them.

The irregularity of the edges of the polar caps indicates that the surface of Mars is no more nearly level than that of the earth, and yet the narrowest canal-like markings the big telescopes reveal must measure 50 miles in width, and the widest nearly 200 miles. Some of them would be 3,000 miles long.

When some one inquired of Prof. Edwin B. Frost, the director of the Yerkes Observatory, if the Martian canals could be seen with the big 40-inch telescope there, he telegraphed the laconic answer: "Yerkes telescope is too powerful."

The late Simon Newcomb showed how easily an astronomer with a low-power telescope might be deceived as to what he saw on the surface of Mars.

At an astronomical convention, Dr. Newcomb made a large white disk. On this he put all sorts of irregular markings resembling those a powerful telescope reveals on Mars. Exhibiting it at a given distance from his fellow astronomers, he asked them to draw what they saw. And when everyone had finished his drawing, not one of them had the irregular markings on his drawing, but all had straight lines resembling the "canals" that observers with small telescopes believe they see, indicating that the small separating power of the eye at that distance was responsible for the "canals."

The question naturally arises whether any other star has a system of planets like our own solar system. This is a question that perhaps can never be answered by direct observation, for there is no present reason for hoping that any telescope can ever be built powerful enough to see such planets shining only by borrowed light. But reasoning by analogy, it is hardly probable that, among nearly two billion stars in our universe, ours should be the only one with a family of planets. We might think that our earth is the only planet with a moon, if we had to depend on our eyes.

DOES LIFE EVER PASS FROM STAR TO STAR?

Then comes the question of interplanetary and interstellar communication of life. Biology has demonstrated that there are forms of life that go into a deep sleep when placed in a high vacuum and surrounded with temperatures approaching that of space. With all that is now known of cosmic dust and its movement through space, there is certainly reason for believing that suspended life, in its lowest forms, might pass from planet to planet or even from dark star to dark star.

Much the greater difficulty would come in finding a suitable environment for the waking bit of life on a new planet or another dark star.

The astronomer and the physicist, in their quest of the truth about the constitution of matter, employ theory and experiment with startling success. Now gathering a mass of clearly related facts, now formulating a theory that will explain these facts and their relationships, now putting that theory to the acid test of proof that in no other way could the accumulated facts be explained, they march on, pushing back the horizon here, lifting the veil of mystery there, and, step by step, getting that knowledge of the behavior of matter which enables the applied scientist to manipulate it for the promotion of human good.

Last summer, at Mt. Wilson, Dr. and Mrs. Charles G. Abbot gave the world a spectacular demonstration of how closely applied science may follow in the wake of theory and experiment. Dr. Abbot, following his studies of the sun, had devised a solar cooker—a sort of trap in which to catch sunbeams and make them take the place of mundane fuel in cooking and baking. He was so successful that piping hot things came to their table all season done to a turn by heavenly fires 93,000,000 miles away.

THE TASK THAT CHALLENGES

If the human race expands from 1925 to 2035 in the ratio that it expanded from 1804 to 1914, the earth will 110 years hence have a population of more than four billion souls.

To feed them, to house them, to provide them with transportation and clothing, and to meet the other multiplying needs of a civilization growing ever more complex, is the task that confronts the applied scientist. But ahead of him must ever go pure science, laying the foundations of truth upon which must be built the superstructure of human progress.

Mt. Wilson, Yerkes, Lick, and the other great observatories of the earth are helping to lay these foundations. And upon their success and the success of their congeners in other fields depends the welfare of our children's children and the other billions of people whom the centuries are adding to our population.

The soup when you're hungry !

Come what may, I lead the fray,
I shine in speed and grace.
From Campbell's meal I get my zeal
To set the winning pace!

Dip your spoon into Campbell's Vegetable Soup and at once you'll understand why it enjoys such vogue as "a meal in itself."

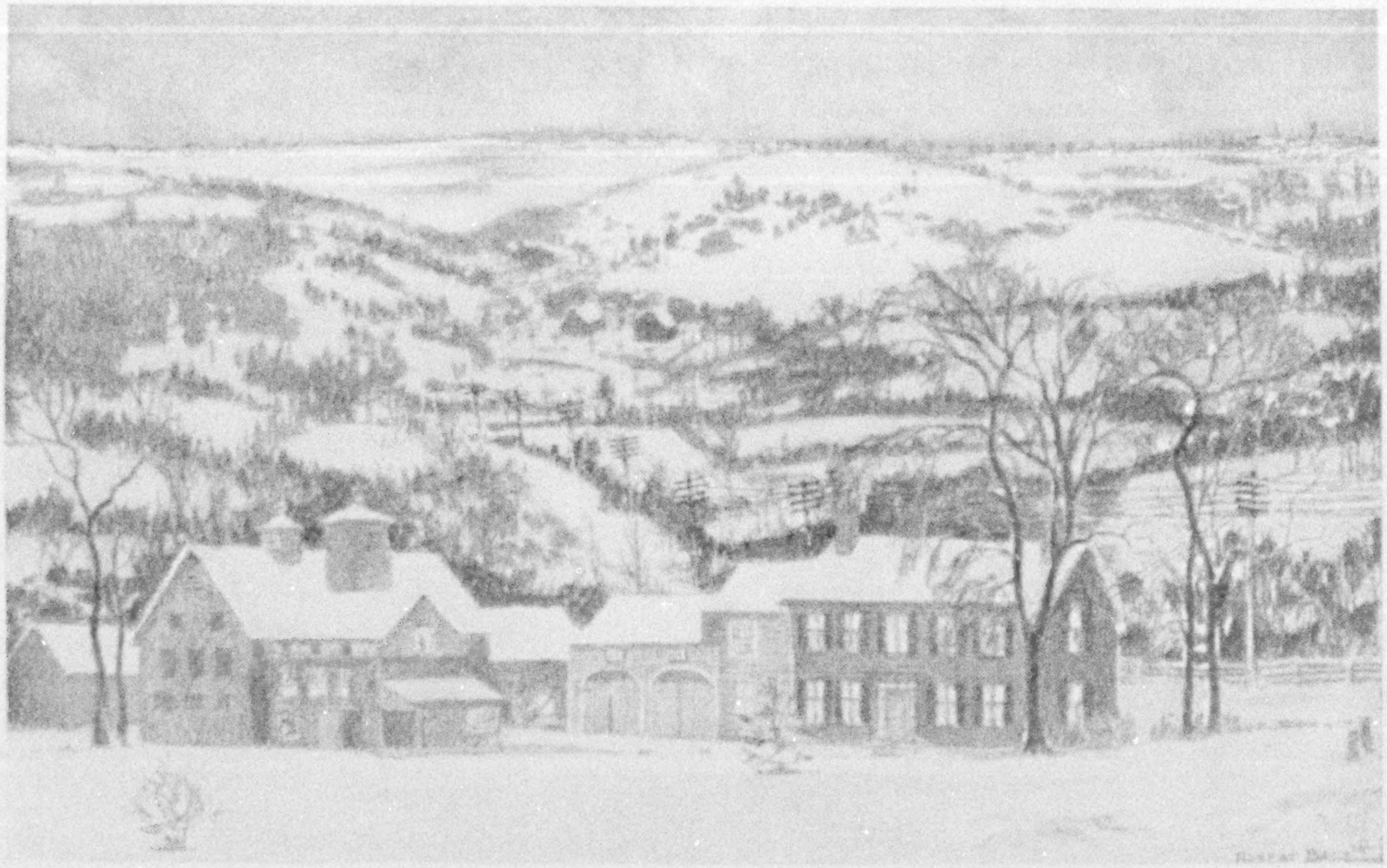
For your spoon will be laden with vegetables, either whole or diced. And with invigorating beef broth, cereals, fresh herbs and delicate spices. Thirty-two different ingredients!

How tempting its flavor is! What a substantial and satisfying dish—luncheon, dinner or supper!

21 kinds

12 cents a can

XUM



NEIGHBORS

When Ephraim Crosby made a clearing far out on Valley Road and built his house, he had no neighbors. He lived an independent life, producing on the farm practically all that his family ate and wore. Emergencies—sickness and fire and protection of his homestead from prowlers—he met for himself. Later he had neighbors, one five and another eight miles away. Sometimes he helped them with their planting and harvesting, and they helped him in turn. Produce was marketed in the town, twenty miles along the cart-road.

Today Ephraim Crosby's grandchildren still live in the homestead, farming its many acres. The next house is a good mile away. But the Crosbys of today are not isolated. They neighbor with a nation. They buy and sell in the far city as well as in the county-seat. They have at their call the assistance and services of men in Chicago or New York, as well as men on the next farm.

Stretching from the Crosbys' farm living-room are telephone wires that lead to every part of the nation. Though they live in the distant countryside, the Crosbys enjoy the benefits of national telephone service as wholly as does the city dweller. The plan and organization of the Bell System has extended the facilities of the telephone to all types of people. By producing a telephone service superior to any in the world at a cost within the reach of all to pay, the Bell System has made America a nation of neighbors.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY
AND ASSOCIATED COMPANIES

BELL SYSTEM

One Policy, One System, Universal Service

Whitman's – Sold in Selected Stores

Whitman's Chocolates are *not* "sold everywhere."

We endeavor to serve the candy-loving public by establishing a sales agency in every neighborhood, but all these agencies are *selected* and each one is supplied *direct* with our candies—not through a middleman.

The Whitman agency is usually the leading drug store, because the drug store nowadays is one of the most progressive service stations of the public.

You may expect good service in every store that shows the sign of a Whitman sales agency. You may count upon receiving perfect chocolates there, in perfect condition. You may go into any Whitman agency, even in remote parts of the country, and buy candy with confidence.

The agent is authorized to give the broadest possible guarantee of satisfaction with every package of Whitman's he sells. Our printed guarantee covers every Whitman product.

It is in the interest of better candy in better condition that we confine the sale of Whitman's to one convenient store in every neighborhood. It is worth the while of any candy-lover to find that store and specify *Whitman's*.

Then at the critical moment, when the package is opened, it will prove your *good judgment* as well as your *good intentions*.

Whether you select The Sampler, The Fussy Package, The Pleasure Island, Salmagundi, or any other of the Quality Group, you may rest assured that your good taste is unquestionable.

STEPHEN F. WHITMAN & SON, Inc., Philadelphia, U. S. A.
New York Chicago San Francisco

Send for "*Samplers Old and New*," an illustrated booklet, sent with our compliments, telling of the revival of an art of olden times. With it we send a book, "*On Choosing Chocolates*," with illustrations.

Take a Kodak with you

When nature beckons, Kodak calls and you put the scene in a picture. It's all easy the Kodak way and pleasure a-plenty as well.

Autographic Kodaks $6.50 up

At your dealer's

Eastman Kodak Company, Rochester, N. Y., *The Kodak City*

That winter vacation *through coupons*

To go where you wish and do what you like. And still to have your source of income in your safe deposit box. The people who can afford to spend their winters where comfort and health are the first consideration are, in the majority of cases, those who have been farsighted in their investment affairs.

Let us help you plan an income-producing investment program based on the ownership of high grade bonds.

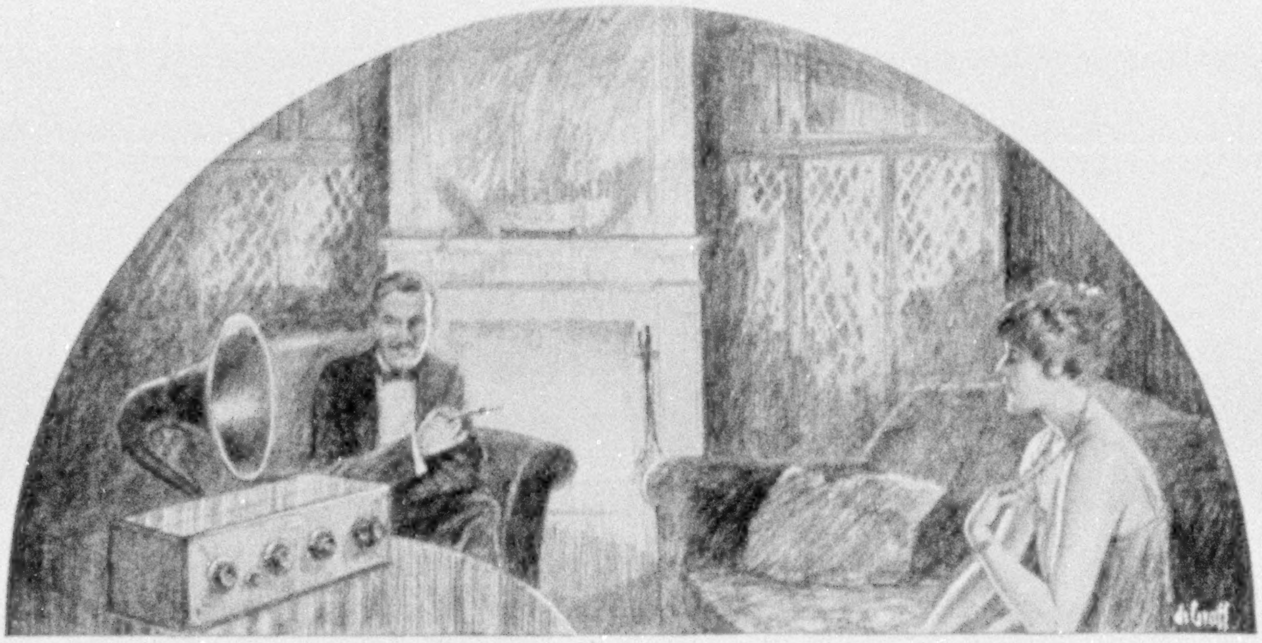
THE NATIONAL CITY COMPANY

National City Bank Building, New York

BONDS — *Offices in more than 50 leading cities throughout the world* — SHORT TERM NOTES

ATWATER KENT

RADIO



You'll Never Forget the Night

YOU'LL never forget the night you first tune in your ATWATER KENT Radio. The thrill of it will live in your memory—the sheer delight of filling your room with living voices or the music from an orchestra perhaps a thousand miles away.

Its clear reception, and the ease with which you can bring in distant stations will be a revelation to you. An added pleasure will come with the knowledge that no one possesses better radio than yours.

ATWATER KENT craftsmen, guided by the experience of skilled engineers, have fashioned the finest materials that money can buy into ATWATER KENT Radio. You will find it combines every feature that means radio satisfaction—unusual selectivity, sensitiveness, distance, volume and tonal quality.

The ATWATER KENT dealer near you will gladly help in the selection of your radio. There is a price, size and style for everyone.

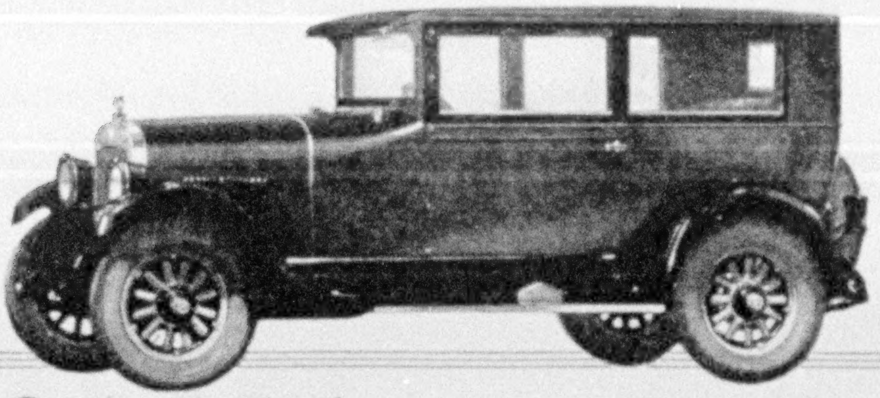
Instructive literature on request

ATWATER KENT MANUFACTURING CO., 4705 *Wissahickon Ave.*, PHILADELPHIA, PA.

THINK OF WHAT IS BACK OF IT

New and Finer Throughout

The new Maxwell bodies are even more handsomely proportioned, with wider, heavier-looking fenders. New and larger radiator. New head lamps, with cowl lamps on all models. Balloon tires, with artillery type wood wheels in natural finish. New steering, even easier, with larger steering wheel and controls at top of steering column. Improved upholstery. New one-piece windshield; cowl ventilator, transmission lock, stop light with tail lamp.



25 Miles *to the* Gallon
58 Miles per Hour
5 *to* 25 Miles *in* 8 Seconds

Fine as the good Maxwell has always been in performing essentials, Chrysler engineers have now made the new Maxwell even finer.

Judged by performing results—by beauty of design and finish—by details of interior upholstery and trim—Maxwell superiority is not only apparent but forcefully emphasized.

What Chrysler engineers have done is to get more out of the four-cylinder principle—to effect a happier and worthier combination of results—than has ever been done before.

Just what it means to get such results from a four, you can easily learn by driving the good Maxwell yourself, or riding while some one else drives.

We say to you in advance that you will marvel that such power and performance, such vibrationless smoothness, can come from a four-cylinder engine.

MAXWELL MOTOR SALES CORP., DETROIT, MICH.

Walter P. Chrysler, President and Chairman of the Board

MAXWELL-CHRYSLER MOTOR COMPANY OF CANADA, LTD. WINDSOR, ONT.

The New Good

MAXWELL

XUM

DODGE BROTHERS TOURING CAR
FOR ALL-WEATHER DRIVING

Widespread comment on the beauty of the car has not overshadowed public appreciation of its really exceptional riding comfort, smoothness of operation and long life.

Bad weather also emphasizes the value of other features—the unfailing response, in extreme cold, of Dodge Brothers powerful starter, and the snug protection afforded by suitable curtain enclosures.

A special enclosure with glass windows, which will provide closed car appearance and comfort, is now available at slight additional cost.

DODGE BROTHERS DETROIT
DODGE BROTHERS (CANADA) LIMITED
WALKERVILLE, ONTARIO

THIS WAY OF OIL HEATING ENDS ALL DOUBT

SCIENCE has found the right way to heat with oil. And proved it for six years. This way is radically different from the old-fashioned methods. It will interest you to see this oil burner that has solved the problem. You need know nothing of mechanics to understand it.

So far as nearly 20,000 present owners are concerned there is no heating problem. Their homes are always exactly the temperature they enjoy. They smell no fumes. They see no dirt or dust. They hear no unpleasant noise. They know that it is safe beyond question.

You, too, will have this experience when you heat your home this scientific way.

One right way to burn oil

Four new facts about oil burning were first used by our engineers six years ago. They are the now famous four natural laws. They explained the difficulties others were having in trying to burn oil.

So we built an oil burner in accordance with those laws. For six winters, now, Oil-O-Matic has answered every demand in thousands of homes, large and small.

The four famous laws

The first law says that oil must be broken up into a fine mist. All other ways violate this law!

After the oil is broken up, the second law demands that it be burned before it touches anything. Carbon and soot will surely result otherwise. So no plates, pots, chamber or any part of an oil burner should be inside your furnace or boiler.

According to the third law, the amount of air that is mixed with the oil must be exact. Naturally this cannot be left to someone's opening or closing a damper. The oil burner itself must measure the amount of air.

The fourth law is just as important. Oil cannot burn perfectly without reflected heat. So unless the firebox of your heating plant is lined with brick, it is impossible to get perfect combustion.

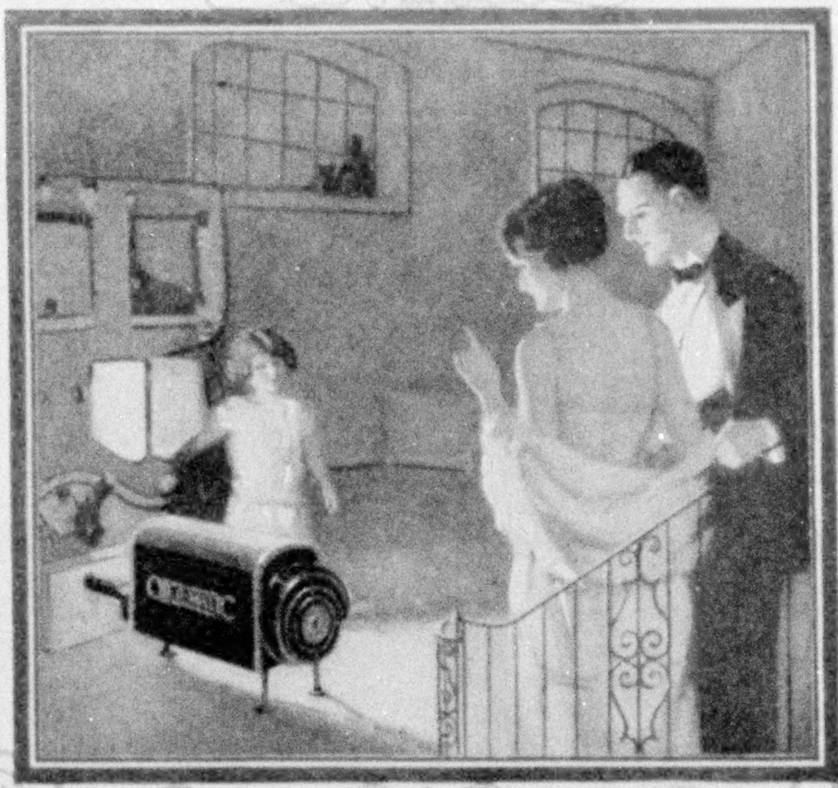
It is this way of burning oil that has made the use of fuel oil really successful for heating homes. It is the method found only in Oil-O-Matic.

Note these exclusive features

There are other features that make Oil-O-Matic different from any other device that burns oil.

We originated and perfected five years ago the Williams Thermal Safety Control. It put an end to the open can designed to catch liquid fuel oil. It ended all worry about the oil not lighting or blowing out.

This positive device watches over your entire plant. Oil-O-Matic can't run at all, unless it runs right. Not a drop of oil can flow. The motor is stopped. Ignition is shut off. This control is the greatest advance in oil burner construction since our application of the four laws.



WILLIAMS
OIL-O-MATIC
HEATING

Proved for six years. Every installation guaranteed. Requires no attention. Burns cheap fuel oil. Clean, quiet, odorless. For buildings of any size. Sold on easy terms.

Works perfectly in any good heating plant

Of course there's no continuous pilot light. That is too wasteful of gas. It has no place on a modern oil burner.

Oil-O-Matic burns a cheap, low gravity oil instead of expensive kerosene and distillate. This gives you more heat units at a lower cost. There will always be an abundance of low-gravity oil.

So this perfected way, approved by leading combustion engineers, ends all doubt. Now no one need be without the comforts of oil heating. Oil-O-Matic can be installed in any good heating plant. Steam, hot water, vapor, hot air.

Sold on easy terms —Guaranteed

The men who install and service your Oil-O-Matic are all trained men. Most of them are graduates of the Williams Institute of Heat Research. They have experience, facilities, organization, and financial responsibility. They are backed by the largest producers of automatic oil burners in the world.

Get the facts now. See it demonstrated. Send the coupon for a copy of "New Facts About Oil Heating." It will answer every question. After you read it you will never go back to coal.

Williams Oil-O-Matic Heating Corp.
Main Office and Plant, Bloomington, Ill.

Largest Producers of Automatic Oil Burners in the World • Dealers Everywhere

MAIL THIS FOR FREE BOOK!

Williams Oil-O-Matic Heating Corp.
Bloomington, Ill. NG15

Please send me at once your booklet, "New Facts About Oil Heating," giving full information about the Oil-O-Matic, and special basement plans for new homes.

Name..........

Address..........

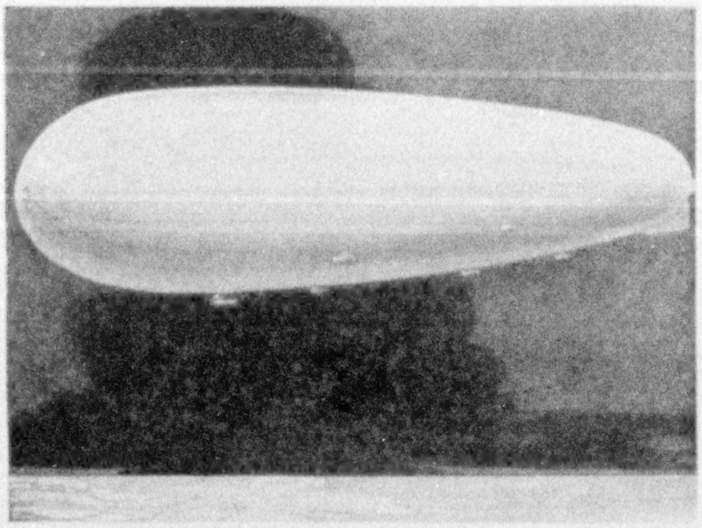
Our Heating Plant is Steam ☐
Hot Water ☐ Vapor ☐ Hot Air ☐

Crane's Cordlinear

The designers of this beautiful paper have cleverly met the demand for a novelty without losing any of the distinction and good taste that have always characterized Crane's writing papers.

The smart cord effect, broken with perpendicular self-tone lines, gives the paper an unusual richness and character without interfering with its smooth writing surface.

EATON, CRANE & PIKE CO., 225 FIFTH AVE., NEW YORK



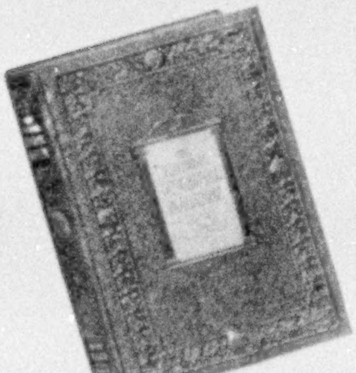
Travel Faster than the ZR-3

with your bound Geographics

ALL mankind marveled at the speed and comfort with which the travelers on the giant dirigible ZR-3 sped westward across the Atlantic.

Yet you can sit in the comfortable depths of your favorite chair and cross the Atlantic, or the Pacific, in a matter of minutes with your Molloy Covered Geographics.

Bind these wonder magazines yourself without glue or thread, in Molloy Geographic Covers. They are of heavy leather cloth, deeply embossed in two-tone brown and gold, and come complete with punch and instructions.



Each cover is designed to hold six numbers, and covers can be supplied for issues back to 1910. Price, $2.00 each or $3.65 per pair. In ordering, please give volume number and year desired. Your money back if you are not pleased.

THE DAVID J. MOLLOY COMPANY
2863 North Western Avenue, Chicago, Illinois

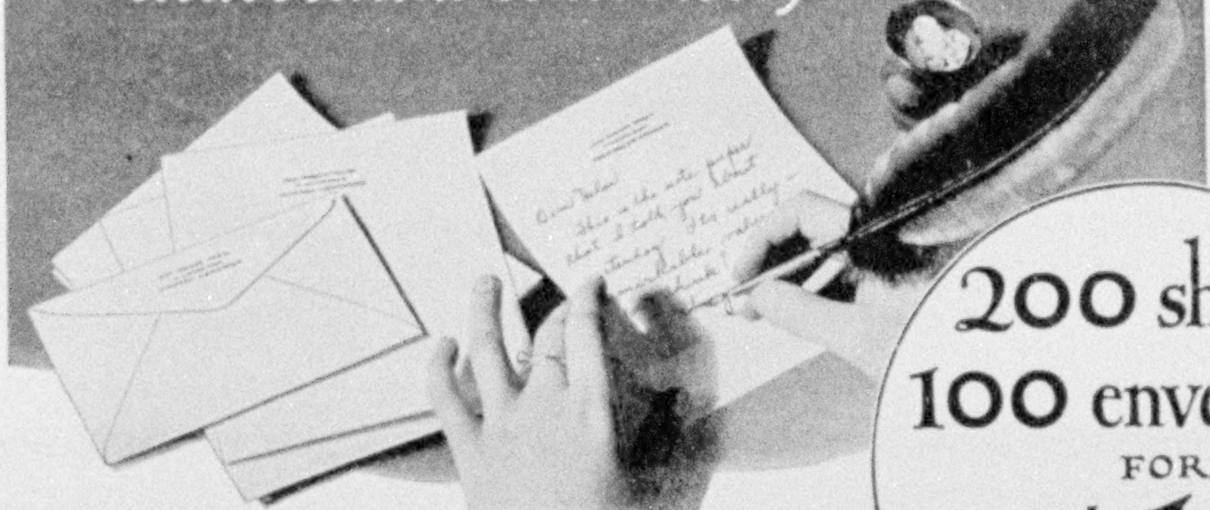
The David J. Molloy Company
2863 N. Western Ave., Chicago

Enclosed find $.................., for which send me..............pairs of Molloy Geographic Covers, Vols..............for years..............
If I am not entirely satisfied, I will return the covers within ten days and you will cheerfully refund my money.

Name ....

Address ....

More than 1,000,000 people *constantly use "AMERICAN" individual stationery*



200 sheets 100 envelopes FOR $1 *delivered to you*

—not because of its low price, but because it fills a definite need in a way which has never been surpassed by anybody else

IT is the vogue today to use "American" Individual Stationery. Within the past few months hundreds of thousands of new friends have been made and added to our gigantic list of permanent, satisfied customers. Think of it—more than a million people are buying this fine stationery by mail from us; and not only that, a majority of them have been regular customers for years and years.

"American" Stationery is not sold in retail stores or through agents—you deal direct with stationery headquarters, the original and largest institution of its kind in the world.

Printed with your name and address in blue ink on Butler's Watermarked National Bank Bond Paper

Our Guarantee—Money Back Without Question if You are Not Satisfied

This business was founded years ago on a basis of square dealing, and it has thrived and prospered accordingly. No matter where you live—whether it be in this country or abroad—you can depend upon fair treatment. You risk absolutely nothing—we assume all of the responsibility for pleasing you.

Our Customers Are Our Best Salesmen

We make no profit on your first order, but our records show and prove that upon receipt of your own stationery you will order for your friends and even go out of your way to recommend "American" to those who you think should use it—that is where we make our profit and that is why we want you to be a satisfied customer. Don't experiment—avoid possible disappointment by ordering "American" Individual Stationery. There is no other just like it.

Only Butler's Watermarked National Bank Bond Paper Is Used

A smooth surface, easy for the pen to glide over, never causing a smudge, yet crisp and aristocratic in its appearance—just what you would expect in stationery costing three or four times as much.

It's watermarked, too, which makes it even more impressive. You will be surprised to receive so much real quality in stationery for so little money.

Send Your Order Today

It is easy to order—just print or write your name plainly on the coupon below. We print it attractively on 200 sheets and 100 envelopes and deliver the order prepaid to you for $1.00. If you live west of Denver or outside of the U. S. enclose $1.10. In ordering for your friends for gift purposes, don't forget to send a card to enclose in each package.

AMERICAN STATIONERY CO.

509 Park Ave. *Serves More than a Million Customers Direct by Mail* **Peru, Indiana**

Sent C. O. D. if You Prefer

If it is more convenient to have your own stationery sent C. O. D., we will gladly do so in the U. S. A. Just pay the postman when the order is delivered. Send your order now and use this coupon for convenience.

To AMERICAN STATIONERY Co., 509 Park Ave., Peru, Ind.

Enclosed is $1.00 ($1.10 if you live west of Denver or outside of the U. S. A.) Please send 200 sheets and 100 envelopes printed with my name and address in blue ink as follows:

NAME.......................................

Street Address.......................................

City and State.......................................

If you want us to ship C. O. D. just put a cross here ☐

For additional orders use the above form on any paper you have handy.

XUM

Across the Atlantic 1925

For schedule and booklet apply to United American Lines, 35-39 Broadway, New York; 171 West Randolph St., Chicago; 574 Market St., San Francisco; 87 St. James St., Montreal.

ATTRACTIVE environment can make your crossing as congenial as a house party.

A distinguished company of experienced travellers is attracted to the cozy, homelike accommodations, long famous cuisine and high standard of service aboard the *de luxe* steamers RESOLUTE, RELIANCE, ALBERT BALLIN and DEUTSCHLAND—and the splendid one-class cabin steamers, CLEVELAND, THURINGIA, WESTPHALIA and MOUNT CLAY. Frequent sailings from New York to Cherbourg, Southampton and Hamburg.

MAIN LOBBY
S. S. RESOLUTE

UNITED AMERICAN LINES
(HARRIMAN LINE)
joint service with
HAMBURG AMERICAN LINE

5-Room ALADDIN $498

WE PAY THE FREIGHT

You can buy all the materials for a complete home direct from the manufacturer and save four profits on the lumber, millwork, hardware and labor.

6-Room ALADDIN $648

Living room, dining room, 2 bedrooms, kitchen, bath. Four other plans, some with pantries and dining alcoves.
Get Free Aladdin Catalog.

12-Room ALADDIN $1775

Dutch Colonial for wide inside lots or narrow corner lots. Full ceiling heights entire second floor, sewing room, columned, inset front entrance.

Price includes all lumber cut to fit; highest grade interior woodwork, siding, flooring, windows, doors, glass, paint, hardware, nails, laths, roofing, with complete instructions and drawings. **Freight paid** to your station. Permanent Homes—NOT PORTABLE. Many styles to choose from. **Write nearest mill today for FREE Money-Saving Aladdin Catalog No. 773.**

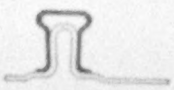
The ALADDIN Co. BAY CITY, MICHIGAN
Wilmington, North Carolina; Portland, Oregon; Toronto, Ontario

---

When you build in Spring

Write for the Higgin Weatherstrip book. It's free.

It's to be a real home—beautiful—roomy—warm. And tight against Winter's weather. Because you're going to give that new heating plant a real chance. You'll not ask it to heat cold air slipping in while air already warmed slips out. Higgin All-Metal Weatherstrips will go on every door and window as you build, insuring a warm, cozy home—tight against dust and soot.



HIGGIN ALL METAL WEATHER STRIPS

Most weatherstrips have the rib strip (the white line) but only Higgin Strips have the patented Insert (the black line) that really keeps the weather out.

THE HIGGIN MFG. CO., 505 Washington St., Newport, Ky.

You Men

Owe to yourselves these whiter teeth

You know that whiter teeth are possible, for you see them everywhere today. Millions attain them through a new method of teeth cleaning. Accept this test and in ten days note what it means to you.

Film is unclean

That viscous film you feel on teeth is what clouds them and destroys them. Under old-way brushing much of it clings and stays. It becomes discolored, forms dingy coats, hides the luster of the teeth.

Film also holds food substance which ferments and forms acid. It holds the acid in contact with the teeth to cause decay. Germs breed by millions in it. They, with tartar, are the chief cause of pyorrhea.

Few escape those troubles when they clean teeth in the old ways.

Dental science has now found two ways to fight that film. One disintegrates the film, one removes it without harmful scouring.

Able authorities have proved these methods effective. So a new-type tooth paste has been created to apply them daily. The name is Pepsodent.

Careful people of some 50 nations now employ it daily, largely through dental advice.

The unique results

Pepsodent also multiplies the alkalinity of the saliva, also its starch digestant. Thus those great natural tooth-protecting factors gain much added power. These combined results bring to users a new dental era.

Send the coupon for a test. Note how clean the teeth feel after using. Mark the absence of the viscous film. See how teeth become whiter as the film-coats disappear.

You will always be glad that you made this test. Cut out coupon now.

Protect the Enamel

Pepsodent disintegrates the film, then removes it with an agent far softer than enamel. Never use a film combatant which contains harsh grit.

Pepsodent REG. U.S. PAT. OFF.

The New-Day Dentifrice

Based on modern research. Now advised by leading dentists the world over.

CUT OUT THE COUPON NOW

10-DAY TUBE FREE 1620

THE PEPSODENT COMPANY

Dept. 407, 1104 S. Wabash Ave., Chicago, Ill.

Mail 10-Day Tube of Pepsodent to

Only one tube to a family.

XUM

Imperial Tables Grand Rapids

CRAFTSMEN with a love of beauty build into your Imperial Table those qualities of fine workmanship which make its possession a constant pride.

See the beautiful Imperial Collections at leading stores. Write Dept. G for handsome free book, "Heirlooms of Tomorrow."

IMPERIAL FURNITURE COMPANY, Grand Rapids, Mich.
"World's Largest Table Factory"

DUES

Annual membership in U. S., $3.00; annual membership abroad, $4.00; Canada, $3.50; life membership, $100. Please make remittances payable to the National Geographic Society, and if at a distance remit by New York draft, postal or express order.

RECOMMENDATION FOR MEMBERSHIP

IN THE

NATIONAL GEOGRAPHIC SOCIETY

The Membership Fee Includes Subscription to the National Geographic Magazine

PLEASE DETACH AND FILL IN BLANK BELOW AND SEND TO THE SECRETARY

....192

To the Secretary, National Geographic Society,
Sixteenth and M Streets Northwest, Washington, D. C.:

I nominate...

Occupation...
(This information is important for the records.)

Address...

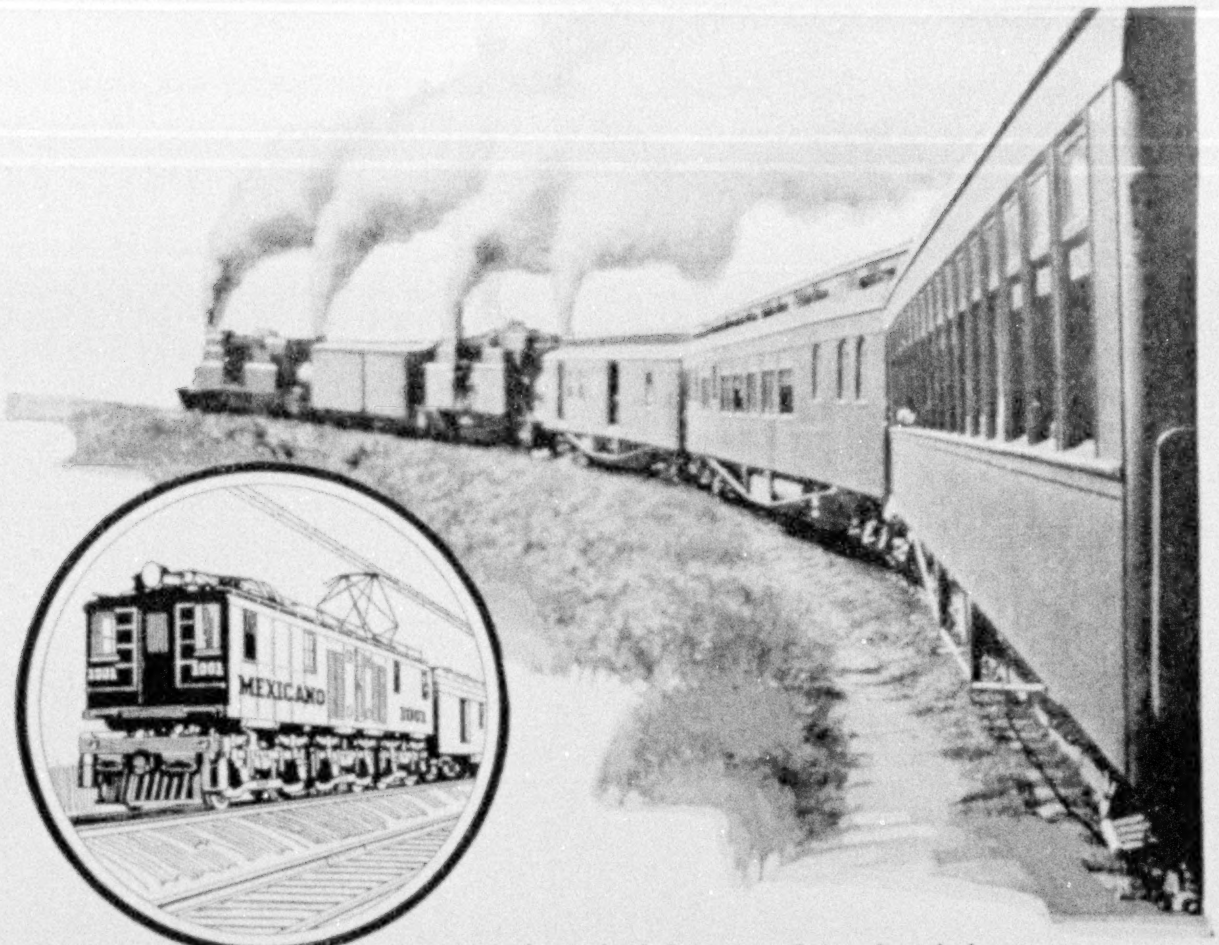
....

for membership in the Society.

....

....
Name and Address of Nominating Member

1-25



In the circle at the left is one of the electric locomotives that will replace the steam engines.

10 locomotives will take the place of 25

Electric locomotives draw long trains 650 miles over the Rocky Mountains on the Chicago, Milwaukee and St. Paul. Eventually most of the railroads in America will be electrified—engineers estimate that this will save more than a hundred million tons of coal a year.

The General Electric Company is electrifying the Mexican Railway between Orizaba and Esperanza. On the first section—with many curves and heavy grades—10 *electric* locomotives will take the place of 25 *steam* locomotives.

Economies resulting from electrification will repay the cost of the improvement within five or six years.

GENERAL ELECTRIC

Picture this Scene in its Natural Colors

Now you can actually photograph color in all its natural tones—imagine this picture coming to colorful, vivid life with the click of an ordinary camera—any plate camera will do.

Agfa
COLOR PLATES

Natural color photography for portraits, landscapes and reproductions of paintings in original colors—daylight, flashlight, arc and nitrogen light exposures. Effectively used for photo-micrography—also in industrial art, technical, medical and surgical science work. Supplied in all sizes through your dealer—or send for instructive information direct.

Agfa
ROLL-FILM FILM-PACK

For Better Pictures

Extremely sensitive, non-curling film, world famous for its clear, brilliant results—the equivalent of a faster lens. *There's a size for every camera.*

If you are not acquainted with the merits of Agfa Roll Film, convince yourself at our expense.

FREE TRIAL OFFER
Without obligation we will send you anywhere in the United States, one spool of Agfa Roll Film—just send this coupon.

AGFA PRODUCTS, Inc.
114 East 13th Street, New York City

Please send me one free spool of Agfa Film.
(No. of spool—or name and No. of Camera)

____

(My Dealer's name and address) ______________

____

(My name and address) ______________

____

Look Inside the Piano for this Trade Mark — WESSELL, NICKEL & GROSS, NEW YORK, TRADE MARK — *The Sign of the World's Standard Piano Action*

The Quality Mark In Choosing a Piano!

THE first question to ask your piano merchant is: "What *action* has the piano?" If it is the Wessell, Nickel & Gross piano action the instrument is bound to be worthy, for this famous action is found only in pianos of proven excellence.

Your piano merchant knows that the Wessell, Nickel & Gross action has stood the test of 50 years and is recognized by the entire music industry as the finest product of its kind. It is the *highest priced piano action built today* and Wessell, Nickel & Gross are the oldest, largest and leading makers of high-grade piano actions.

The octagonal symbol of the world's standard piano action is a quality mark—worth looking for—worth *insisting* upon.

WESSELL, NICKEL & GROSS
Established 1874 New York City

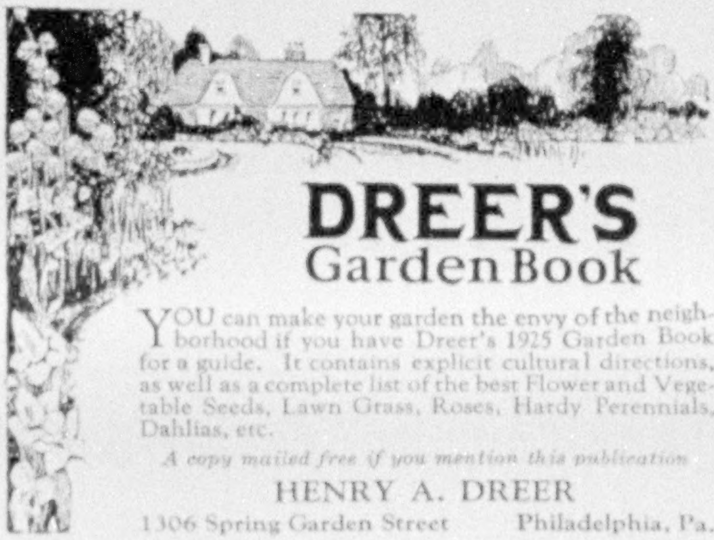
When you Buy an Upright, Grand, Player or Reproducing Piano—Insist on the Wessell, Nickel & Gross Piano Action.

HARRISON MEMORIALS

Whether elaborate or inexpensive, are always executed artistically and in good taste.

Write for Booklet "C"

HARRISON GRANITE COMPANY, Inc.
200 Fifth Avenue *Established 1845* New York, N. Y.
Offices: Detroit Chicago Pittsburgh Minneapolis
Works: Barre, Vermont



DREER'S
Garden Book

YOU can make your garden the envy of the neighborhood if you have Dreer's 1925 Garden Book for a guide. It contains explicit cultural directions, as well as a complete list of the best Flower and Vegetable Seeds, Lawn Grass, Roses, Hardy Perennials, Dahlias, etc.

A copy mailed free if you mention this publication

HENRY A. DREER
1306 Spring Garden Street Philadelphia, Pa.

"Put 'em up – quick!"

Closing time . . no customers about . . the proprietor checking a busy day's receipts . . THEN—a snarl from the doorway: "Put 'em up—quick!" . . A threatening pistol . . a clerk's scream . . the cash drawer emptied . . All in a twinkling . . Only a feeling of helplessness left.

HOLD-UPS are increasing, both in number and boldness. Robbers, too, have developed an almost uncanny technic. Today some clever criminal may be studying *your* place of business. Within a few hours *your* cash may become the loot of some brutal thug.

For a few cents a day, an Ætna Office and Store Robbery Policy will safeguard your valuables. Let the Ætna-izer explain how you can be freed from the risk of defending your possessions.

ÆTNA-IZE

The Ætna Life Insurance Company and affiliated companies issue virtually every known form of policy—Life Insurance in all its branches; Group Life; Group Disability; Accident and Health; Automobile; Compensation; Liability; Burglary; Plate Glass; Water Damage; Fire; Marine; Transportation; Fidelity Bonds; Surety Bonds, etc.

Ætna-ize according to your needs—as you prosper and as your obligations increase.

TODAY, in virtually every community of America, an intelligent Ætna representative stands ready to provide the exact insurance protection you need. Get acquainted with the Ætna-izer in *your* town. He is a man worth knowing.

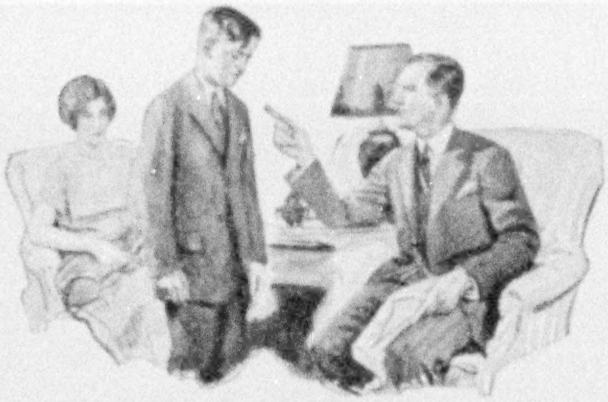
The Ætna Life Insurance Company and affiliated companies are the strongest multiple-line insurance organization in the world. And back of this *security* is a record of settling every honest claim in full.

ÆTNA LIFE INSURANCE COMPANY AND AFFILIATED COMPANIES

ÆTNA CASUALTY AND SURETY CO. AUTOMOBILE INSURANCE CO., OF HARTFORD, CONNECTICUT

XUM

The world forgives him now, but—



Today you, and the world too, make allowances for your boy and forgive his little disobediences—his childish bursts of temper—even a detected falsehood.

But when he becomes a man the world will stop forgiving. It will judge him solely by what he shows it. And between the ages of ten and twenty he is forming the character the world will see.

THE AMERICAN BOY can help you in making a man of him. He learns to admire the real men, fine boys, who work, play and *live* with him in its stories. Unconsciously he accepts their standards of life, and emulates their fineness of character—their loyalty and courage, their honor, self-control, initiative, industry and self-reliance. He learns to know and trust and depend on himself—to do right, think right, live right—to accept responsibility for errors, and to profit by them. With unperceived hands—with unfelt power—THE AMERICAN BOY leads him to manhood.

Let THE AMERICAN BOY guide your son through the crucial, character-forming stage of his life. Send us the coupon below—you need not enclose any money—and we will mail your boy the current issue of THE AMERICAN BOY. A bill for two dollars, covering a year's subscription, will be sent you later, unless you notify us to the contrary within ten days.

$2.00 a year by mail. 20c a copy at news-stands

The American Boy

"The Biggest, Brightest, Best Magazine for Boys in All the World"

THE SPRAGUE PUBLISHING CO.
No. 292 American Building, Detroit, Mich.

Please enter a year's subscription to THE AMERICAN BOY and send a copy of the current issue to the following address. Unless I notify you to the contrary within ten days of the receipt of it, I will remit $2.00 on receipt of your bill.

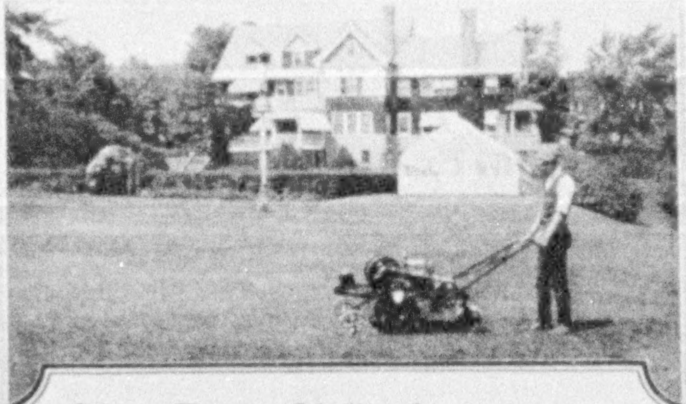
Boy's Name ....

Address ....

Your Name ....

Address ....

If you prefer, remit $2.00 with order
Canada, $2.25; foreign, $2.50



Cuts Four-fifths from Cost of Lawn Mowing

One man with an Ideal Power Lawn Mower will do as much work as five or more with hand mowers. As he mows he also rolls the lawn smoothly, saving the labor of a separate operation. Figure your saving.

An Ideal is simple and will last for years. Any caretaker can operate it. More Ideals are in use today than all other makes combined. Interesting literature on request.

Ideal Power Lawn Mower Co.
R. E. Olds, Chairman
422 Kalamazoo St., Lansing, Michigan
New York, 13-19 Hudson St. Chicago, 11 E. Harrison St.
Dealers in all Principal Cities

IDEAL (102)
Power Lawn Mowers

"The Star Guide to Good Roses"

makes rose-growing a delightful pastime. 100 pages, 18 in full color. ***Best catalog we've ever issued.*** Contains our exclusive new feature, the Star Index, showing America's 100 best roses. New "Guide" tells the truth about every rose in the Index, and many more, including the year's novelties.

Write today and get to know roses as you've never known them before. The "Star Guide" is FREE, and sent postpaid.

THE CONARD-PYLE CO.
Formerly Conard & Jones Co.
★ *Star Rose Growers* ★
Robert Pyle, Pres. Box 8 West Grove Pa.

PLAN YOUR FUTURE HOME *NOW*

with Stillwell California Style (All-climate)

PLAN BOOKS

"All-American Homes"
50 houses, 7 to 10 rooms—$1

"The New Colonials"
50 houses, 6 to 10 rooms—$1

"S. W. Stucco Homes"
75 duplexes & bungalows, $1

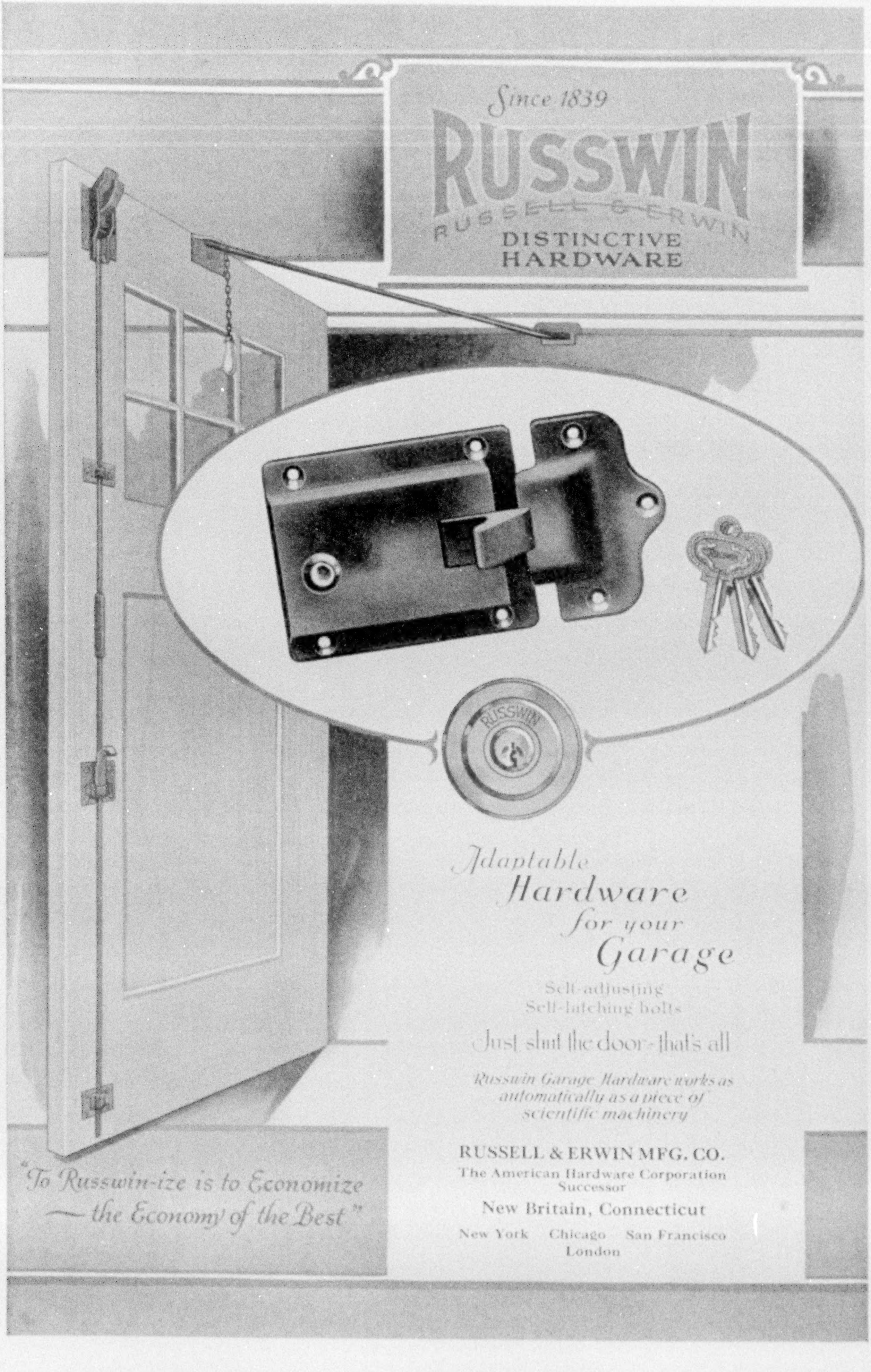
"West Coast Bungalows"
50 houses, 6 and 7 rooms—$1

"Little Bungalows"
75 houses, 3-4-5 rooms—$1

SPECIAL OFFER. Send $2.50 for any three of these books and get Garage Folder FREE.

Money back if not satisfied

E. W. STILLWELL & CO., Architects, 277 Cal. Bldg., Los Angeles


Since 1839
RUSSWIN
RUSSELL & ERWIN
DISTINCTIVE HARDWARE
RUSSWIN
Adaptable Hardware for your Garage
Self-adjusting
Self-latching bolts
Just shut the door - that's all
Russwin Garage Hardware works as automatically as a piece of scientific machinery
RUSSELL & ERWIN MFG. CO.
The American Hardware Corporation Successor
New Britain, Connecticut
New York Chicago San Francisco London
"To Russwin-ize is to Economize — the Economy of the Best"

XUM

Hear Ye! Hear Ye!

LOVERS OF COFFEE
THE COFFEE PROBLEM IS SOLVED!

A CUP OF HOT WATER, ONE TEASPOONFUL OF

G. Washington's

DELICIOUS INSTANT COFFEE

SUGAR AND CREAM TO TASTE.

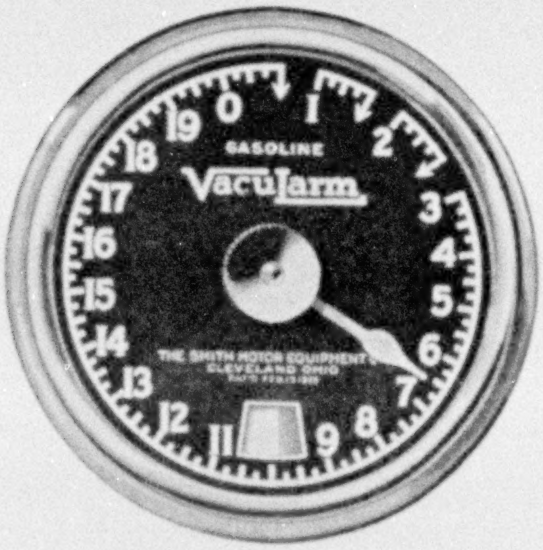
EACH CUP TO ORDER AT TIME OF SERVICE

WITHOUT TROUBLE OR FAILURE.

UNIFORM QUALITY GUARANTEED

Send 10c for Special Trial Size Recipe Booklet Free

G. WASHINGTON COFFEE REFINING CO. 522 Fifth Avenue, New York



VacuLarm

On the Instrument Board of Your Car

Blows Horn when Gas is Low

Tells exact amount in tank. Vacuum Indicator warns of trouble in advance.

At your dealer's or by Parcel Post, prepaid, with complete instructions on receipt of price—$8.90. Installed in 20 minutes. Money back in 30 days for any reason.

THE SMITH MOTOR EQUIPMENT COMPANY
1952 West 77th Street Cleveland, Ohio

OWN A BAROMETER

and Foretell the Weather

This reliable Barometer enables you to predict accurately any change in weather 8 to 24 hours in advance. Scientifically constructed, attractive in appearance. Highly polished mahogany case, silvered metal dial, heavy bevel glass front. Size 5½ inches.

AN IDEAL GIFT

Makes a highly prized and lasting gift. Educational, useful and interesting. Indispensable to motorists. Should be in every home. Fully guaranteed; postpaid to any address on receipt of **$5.00**

DAVID WHITE, Dept. 110, 419 E. Water Street
Milwaukee, Wisconsin

200 Sheets — 100 Envelopes

$1.00

Postage Prepaid

High grade, clear, white bond paper — unusually smooth writing surface. Size 6 x 7 inches with envelopes to match. Has that crisp, crackly "feel" that identifies it to everyone as superior quality stationery. Special handy box keeps paper and envelopes in order and easily reached, preventing waste.

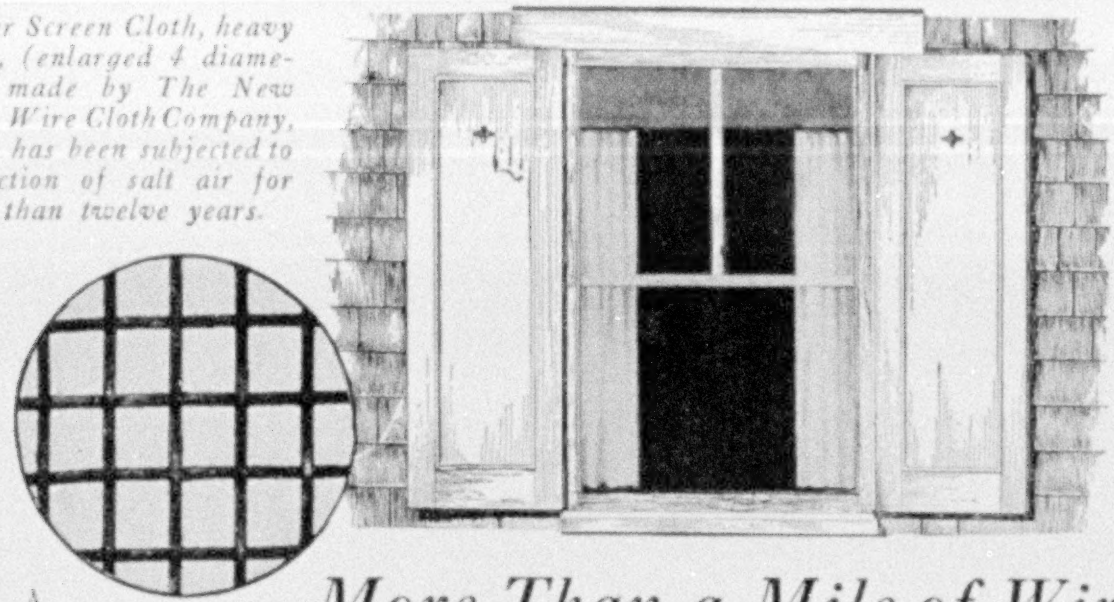
Your Name and Address Printed FREE

on every sheet and envelope, in rich dark blue, up to 4 lines. Type is Plate Gothic, designed especially for clearness and good taste. Makes a personal stationery you will be delighted to use. An ideal gift printed with your friend's name. This stationery, unprinted, would ordinarily cost you more than $1.00; our large production at narrow margin makes this special offer possible.

Just send your name and address (write or print clearly) with $1.00 (west of Denver and outside the U. S. $1.10) and this generous box of stationery will come to you neatly packed, postage prepaid. Money returned if you are not more than satisfied. Order today!

National Stationery Co. 1551 Lincoln Highway
Batavia, Illinois

Copper Screen Cloth, heavy grade, (enlarged 4 diameters) made by The New Jersey Wire Cloth Company, which has been subjected to the action of salt air for more than twelve years.



If the wire used to make an average size window screen were stretched vertically in a single strand it would reach to a height

Seven times that of the Woolworth Building

More Than a Mile of Wire

A full size window screen contains more than a mile of wire. Every fraction of an inch of that wire must be perfect and remain perfect in order to afford the protection to which you are entitled when you buy insect screen cloth.

The wire used in Jersey Copper Insect Screen Cloth is made of unalloyed copper 99.8% pure—the most durable metal in common use. Jersey does not depend for its durability upon a thin protective coating as does steel cloth, metal-coated, nor upon a perfect mechanical mixture of metals as do "bronze" cloths, and so, whether you take one inch or five thousand miles of wire in Jersey Copper Screen Cloth, it is uniform in composition.

Another unique quality of Jersey, second only to its superior durability, is its stiffness and strength. This is made possible by a special Roebling process through which the wire passes. It is an exclusive feature of Jersey Copper Screen Cloth and gives it stiffness and strength comparable to that of steel.

Talk to your hardware merchant or custom-made screen manufacturer. If he does not have it write us and we will send you a sample, also an interesting booklet and tell you how you can get it.

THE NEW JERSEY WIRE CLOTH COMPANY
634 South Broad Street
Trenton New Jersey

TRADE JERSEY MARK

Copper Screen Cloth

Made of Copper 99.8% Pure

XUM

This X-Ray view shows tooth socket destruction by Pyorrhea

Perfect teeth—

the X-Ray tells if they are in danger

YOUR teeth may be perfect—white and untouched by decay—but unless you keep your gums healthy and firm, pyorrhea is almost certain to develop. The X-Ray reveals how quickly the infection of pyorrhea spreads to the root sockets which support your teeth. If pyorrhea is not checked, the teeth fall out or must be pulled.

Tender, bleeding gums

—flash the signal that pyorrhea is gaining a foothold. A most effective dentrifrice for preventing and checking pyorrhea—as proved by dental clinics since 1908—is Pyorrhocide Powder.

The tonic and stimulating qualities of Pyorrhocide Powder correct bleeding gums, strengthen tender gums, harden soft gums. It keeps the teeth white and clean. It is medicated with Dentinol, a gum-tissue healing agent used by dentists in the treatment of pyorrhea.

Pyorrhocide Powder keeps healthy gums healthy. Its daily use—with proper dental care—will guard you from pyorrhea. The economical dollar package contains six months' supply. At all druggists. Send for free sample and booklet on causes and prevention of pyorrhea.

FREE Sample

THE DENTINOL & PYORRHOCIDE CO., Inc.
(Sole Distributors)
1478 Broadway, New York City.
Send me free sample of Pyorrhocide Powder and booklet.

Name ....

Address ....

....

The Most Popular Stub

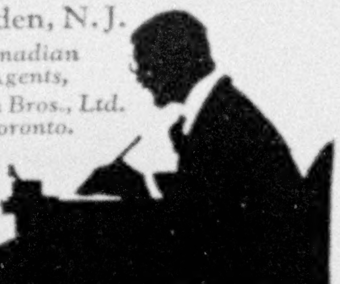
More Esterbrook Jackson Stubs have been used than any other stub pen ever made! If you like to write with a medium stub pen, rather firm in action, you'll surely like this one.

Like all Esterbrook pens, the Jackson Stub is made of the finest tempered steel. Each pen is rigidly inspected, and is a perfect writing instrument.

Booklet of 100 famous signatures, and the 12 most popular pens in the world, sent on receipt of 15 cents.

Address Department N
Esterbrook Pen Mfg. Co.
Camden, N.J.

Canadian Agents,
Brown Bros., Ltd.
Toronto.



Always a FRESH Esterbrook

GERMAN ARMY OFFICERS'

FIELD GLASSES

Brand New

8 Power $9.85 Postpaid

Genuine German War glasses purchased at exceptionally advantageous rates of exchange.

Manufactured by most prominent of German optical factories. Many were received direct from the Allied Reparations Commission.

Finest achromatic day and night lenses. 40 m. m. objective. Dust and moisture proof. Pupillary adjustment. Built regardless of cost according to strictest military standards. All glasses guaranteed in perfect condition.

Shipped promptly upon receipt of check or money order for $9.85, under positive guarantee of full cash refund for any glasses returned.

Order your field glasses today

HENDERSON BROTHERS

Largest importers of field glasses in America

97 Federal Street — Boston, Mass.

Bring the garden inside the house

The perfect clarity of Plate Glass makes the environment of a house part of the interior decoration. The glowing colors of flowers and the play of sunlight on trees and vines are brought into every room in the house. From the outside the highly polished surfaces reflect lights and shadows with a fidelity and brilliance impossible to ordinary window glass. Plate Glass literally transforms the appearance of the house, inside and out.

Use PLATE Glass

©

Nothing Else is Like it

The cost of glazing a house with Plate Glass is not more than one per cent of the total cost of the house. Through increased selling or renting value, and in increasing satisfaction and pleasure to the owner, Plate Glass returns far more than the original investment.

Whether you build a large or small house, specify Plate Glass. Your architect will gladly furnish you comparative estimates.

Plate Glass Manufacturers *of* America

XUM

Readers First—

YOU—Mr. and Mrs. Reader and Miss and Master Reader—are the all-important considerations to those charged with issuing the NATIONAL GEOGRAPHIC MAGAZINE.

Your interests, needs, and pleasure are paramount. This holds for advertising pages as well as for every article and illustration.

That no deceptive advertising be admitted is its first concern. THE GEOGRAPHIC takes special pains to check up new products. Its representatives investigate them and interview users, obtain reports from Government sources, or employ experts before accepting any such advertisements.

But THE GEOGRAPHIC goes still farther. It is not enough for an advertiser to be honest. THE GEOGRAPHIC holds that a periodical has no right to waste a reader's time with a mass of inapplicable advertisements that will not help him or her to make life richer and more efficient, nor to offend good taste by publishing cheap or unpleasant copy. It declines many pages each year solely on such grounds.

For the young people, THE GEOGRAPHIC sees to it that nothing that will start dubious trains of thought in youthful minds finds entry. By the way, have you considered the effect of unsupervised advertising on your young people?

DO you approve of such clean, safe, time-saving advertising? Your one practical way of furthering this policy is by giving preference to the acid-tested advertisers whose products and services come to your notice through THE GEOGRAPHIC.

National Geographic Magazine

WASHINGTON, D. C.

Write for the new Kunderd Catalog—QUICK

SEND for my new 1925 Gladioli catalog at once and get the benefits I offer for early orders. Choice, new varieties of Kunderd Gladioli now offered for the first time. Catalog describes hundreds of varieties. Many illustrated in color. My full cultural instructions are included. Send for the catalog right away.

A. E. KUNDERD, Box 62, Goshen, Ind., U. S. A.
The Originator of the Ruffled and the Laciniated Gladioli

Kunderd TRADE-MARK *Gladioli*

THEY STAND SUPREME

BRIGHTEN UP YOUR ROOMS
By Changing Pictures Often

It is so easy to hang pictures when you use

Moore Push-Pins
Glass Heads—Steel Points

Moore Push-less Hangers
"The Hanger with the Twist"

You will enjoy changing them around often and adding new ones. The fine tool-tempered steel points enter the wall at a proper angle to support heavy weights.

10c. Pkts. Everywhere

Moore Push-Pin Co., Philadelphia, Pa.

THIS MAGAZINE IS FROM OUR PRESSES

JUDD & DETWEILER, INC.
Master Printers

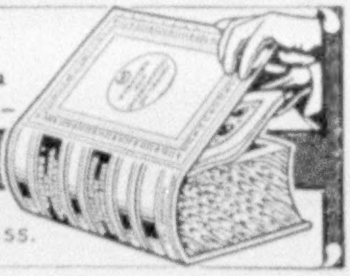
ECKINGTON PLACE AND FLORIDA AVENUE WASHINGTON, D. C.

Whatever Your Question;—be it the pronunciation of Fascista, the spelling of a puzzling word, the location of Esthonia the meaning of soviet, realtor, vitamin, etc., this Supreme Authority—

WEBSTER'S NEW INTERNATIONAL DICTIONARY

contains an accurate, final answer.

407,000 Words 2700 Pages 6000 Illustrations
Regular and India-Paper Editions
G. & C. MERRIAM CO., Springfield, Mass.
"The Magic of Words" and Pocket Maps FREE if you mention The Geographic



No. 44—The "Invincible" is silvered and dome pointed.

One of 50 styles.

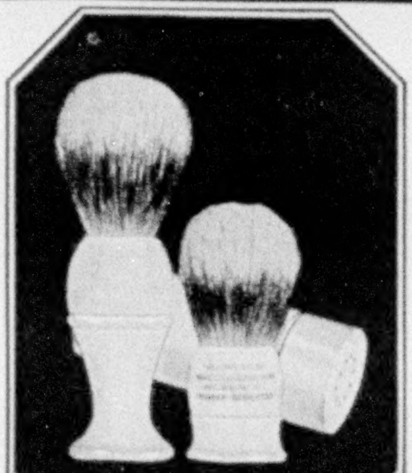
Spencerian *Personal* Steel Pens

Here is a pen that writes more smoothly than a lead pencil. The "Invincible"—Spencerian Personal Steel Pen No. 44—is broad shouldered, built to carry a big load of ink and do a man's work. It is used extensively by banks and bankers and business men. Like all hand-built Spencerians, "Invincible" has remarkable wearing qualities. Remember that one of the 50 Spencerian Pens was designed for your particular handwriting.

Mail 10c for 10 sample pens and free booklet, "What your handwriting reveals."

SPENCERIAN PEN COMPANY
349 Broadway New York

For a Generation of Daily Use



A generation of daily usage is built into every WHITING-ADAMS Shaving Brush.

WHITING-ADAMS BRUSHES work perfectly and hold together until actually *worn* out.

WHITING-ADAMS BRUSHES

The satisfaction of using a WHITING-ADAMS Shaving Brush increases day by day. They *satisfy—serve*—and *survive!*

JOHN L. WHITING-J. J. ADAMS CO., BOSTON, U. S. A.
Brush Manufacturers for Over 116 years and the Largest in the World

A Warm House When You Arise

This Easy Inexpensive Way

Make This Test

Chamberlin Inside Door Bottoms enable you to admit fresh air to any part of the house, while sealing all other parts against drafts.

Try This Experiment

Open your bedroom windows. Close the door, then place your hand at the crack between the bottom of the door and floor. Note the draft of cold air which rushes through the crack into the hall.

Try this at the attic and basement as well. There will be a draft at each. It goes on all night from bedrooms, constantly from the basement, while warm air escapes to the unused attic. That is why bath and breakfast rooms are almost always cold in the morning.

CHAMBERLIN METAL WEATHER STRIPS
"SINCE 1893-THE STANDARD"

and Inside Door Bottoms

We gladly furnish free estimates covering the cost of installing weather strips or inside door bottoms or both in your home. When installed they are guaranteed for the life of the building. Simply mail the coupon.

Chamberlin Metal Weather Strip Company
1650 West Lafayette Boulevard, Detroit, Michigan
I would like an estimate covering the cost of installing (check which)
Chamberlin Inside Door Bottoms—
Chamberlin Metal Weather Strips—In my home—Office Bldg.—Church—Number of Windows—Number of Doors—

Name..

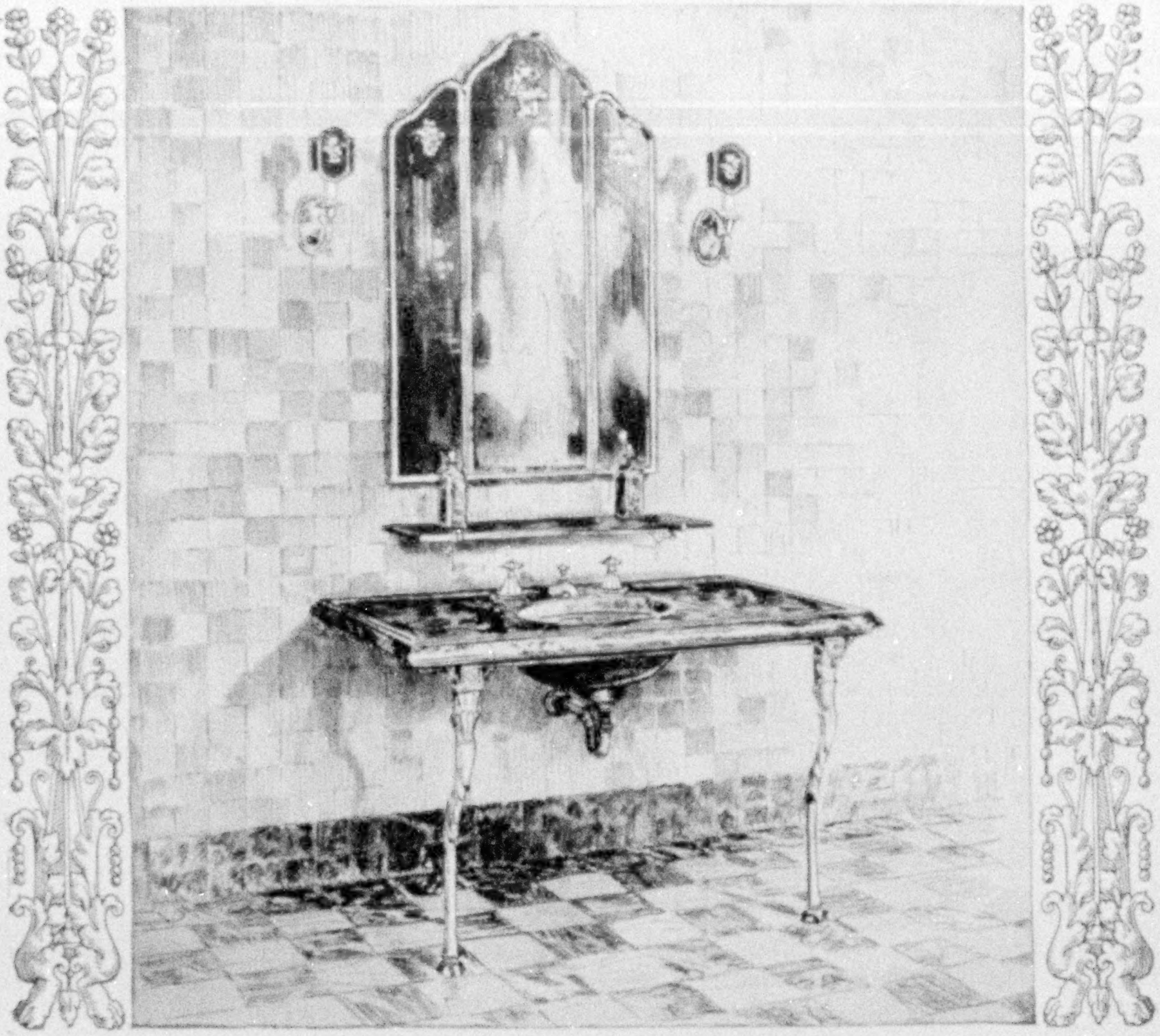
Address..

City and State..

Eng. Dept. W-1

XUM

CRANE BEAUTY IN THE OPEN: CRANE QUALITY IN ALL HIDDEN FITTINGS



CRANE NEUMAR LAVATORY OF BLACK ITALIAN MARBLE, GOLD VEINED: METAL PARTS FINISHED IN HEAVY GOLD PLATE

THE most luxurious bathroom fixtures serve no better than their supply and drainage fittings. Buried from view behind walls or beneath floors, these arteries of a plumbing system are often neglected.

Few realize the number and importance of the valves and fittings used even in modest homes. These need to be chosen as carefully as the fixtures whose beauty gives a bathroom character and charm.

Crane fixtures and materials, sold only through plumbing contractors, assure lasting satisfaction when properly selected and installed. Let us send you a copy of our book of color schemes, "The New Art of Fine Bathrooms".

CRANE

GENERAL OFFICES: CRANE BUILDING, 836 S. MICHIGAN AVE., CHICAGO
CRANE LIMITED: CRANE BUILDING, 386 BEAVER HALL SQUARE, MONTREAL

Branches and Sales Offices in One Hundred and Forty-eight Cities
National Exhibit Rooms: Chicago, New York, Atlantic City, San Francisco and Montreal
Works: Chicago, Bridgeport, Birmingham, Chattanooga, Trenton and Montreal

CRANE EXPORT CORPORATION: NEW YORK, SAN FRANCISCO, SHANGHAI
CRANE-BENNETT, LTD., LONDON
CIE CRANE: PARIS, NANTES, BRUSSELS

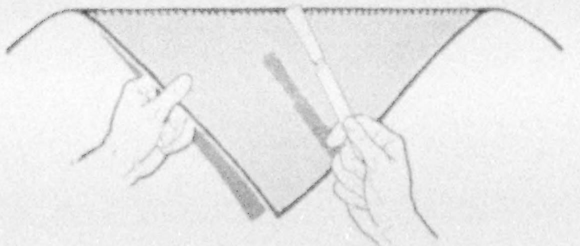
Dirt Can't Hide From The Hoover

Deeply embedded in the nap of your rugs, dirt hides! It can only be beaten out! You can prove this.* Thus, to keep your rugs immaculate you need a Hoover, for The Hoover BEATS . . as it Sweeps, as it Cleans. And with remarkably efficient cleaning attachments you can do the rest of your household cleaning with ease and comfort, quickly, dustlessly. Your Authorized Hoover Dealer will deliver a Hoover complete for *Only Six Dollars and Twenty-Five Cents Down!*

The HOOVER

It BEATS.... as it Sweeps as it Cleans

* To prove rugs need beating: Turn over a corner of a rug; with the butt of an ordinary table-knife, or something of equal weight, give the under or warp side 15 to 25 sharp *taps* and watch the dirt dance out from the nap depths onto a piece of paper; feel the destructive character of this grit. *This is the dirt only beating will dislodge.* Correctly cleaned by a Hoover, embedded dirt is thus *vibrated* to the surface by the rapid, gentle *tapping* of the Hoover brush, as powerful suction *lifts* the rug from the floor.

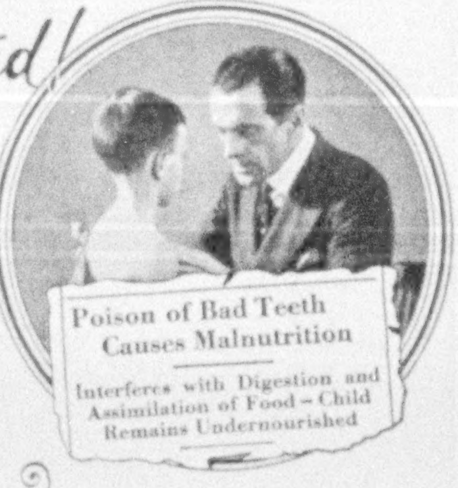


THE HOOVER COMPANY, NORTH CANTON, OHIO

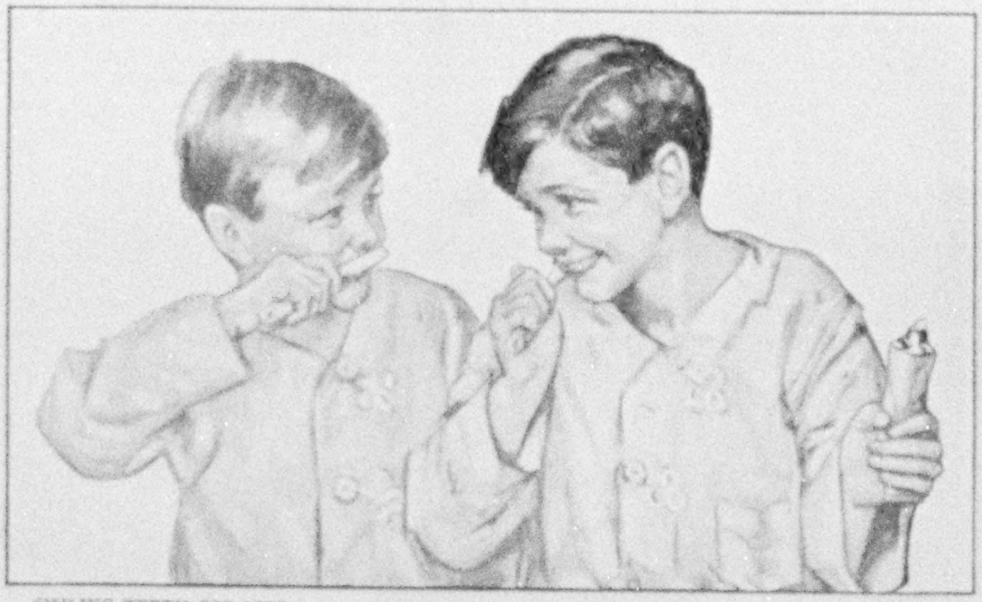
The oldest and largest maker of electric cleaners · The Hoover is also made in Canada, at Hamilton, Ontario

PRESS OF JUDD & DETWEILER, INC.
WASHINGTON, D. C.

This might have been prevented!



Don't wait to counteract tooth trouble
Prevent It!
Colgate's *removes causes* of tooth decay



SMILING TEETH FOR LIFE — BY MAUD TOUSEY FANGEL

THE time to fight unhealthy teeth is before disease sets in—not after. Give yourself and your family a chance to escape disease by the most effective and inexpensive method in the world—prevention.

Preventive science is the new development in dentistry. Its aim is to keep teeth healthy—and teeth can be kept healthy only when they are kept clean. Healthy teeth are as necessary to beauty as pretty eyes and a lovely complexion.

Causes of tooth decay must be removed—safely. Soap and chalk, scientists say, are the best agents yet discovered for cleaning teeth safely—and these are ingredients of Colgate's Ribbon Dental Cream.

"Washes," Polishes and Protects

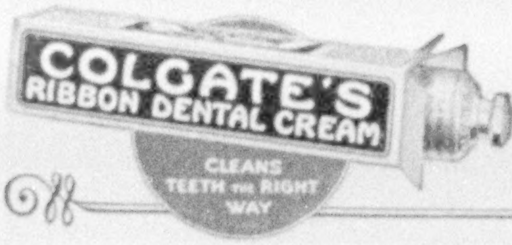
Colgate's does not scrape teeth clean. It washes them gently and thoroughly. Washing action results from the mild vegetable oil soap. The chalk removes clinging particles of food and the soap washes them away. The mouth is left in its normal condition—refreshed and clean.

There is no grit in Colgate's, for grit scratches tooth enamel and thus invites decay instead of fighting it. Colgate's contains no dangerous ingredients. Its function is to cleanse and protect.

The Safe Course

See your dentist at least twice a year and use Colgate's regularly. It is priced as sensibly as it is made—25c for the large tube.

COLGATE & CO.
Established 1806



BAD TEETH and malnutrition are closely associated. In the United States 68% of the school children have defective teeth: 22.7% suffer from malnutrition. (Authoritative figures.)

Dr. Robert Hugh Rose, in his book "Eat Your Way to Health," says, "If these defects were confined to the poor it would not be such a reflection upon our conception of how to nourish the nation, but the rich suffer about the same as the poor."

When teeth decay, either from faulty diet or from lack of care, development of the child is retarded both physically and mentally. Poison from decaying teeth permeates the body. Then serious trouble starts. Dread diseases may develop. Even life itself may be cut short.

Many cities have undertaken preventive dentistry in the schools. Philanthropic organizations have taken hold. Big business institutions are making tooth care compulsory. It means better work from employes, and fewer absences.

As education advances—as the serious effects of unhealthy teeth are becoming known—more and more forces are combating this national defect. Conditions can greatly be improved.

Give the child a chance!

These New York City school children are being given a chance to escape the consequences of unhealthy teeth.

Healthy mouths lessen the danger of "catching" disease.